ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Vol. XLIV. No. 21.

TABLE OF CONTENTS:

ENGINEERING NEWS OF THE WEEK.....345, 358
A Footway Suspension Bridge with Three Towers at Easton, Pa. (illustrated)..... 346
Notes on Recent Improvements in Foreign Shipbuilding Plants..... 346
Spirit Levels on Engineer's Field Instruments (illustrated)..... 348
Launch of a Cruiser and a Battleship (with two-page plate and other illustrations)..... 350
The "Burning" or Mending of Castings (illustrated). 351
Civil Service Examination Questions for Structural Iron Designers (illustrated)..... 352
The Possibilities of American Competition with Foreign Shipbuilders in Building Large Ocean Vessels. 352
Book Reviews..... 359
Moving Water Horizontally by Air-Lift Pumps at Point Pleasant, Pa. (illustrated)..... 359
Investigation as to Virtual Grades; Canadian Pacific Ry. (illustrated)..... 360
The Explosion at the Red Ash Colliery, Fayette Co., W. Va. (illustrated)..... 361
Annual Meeting of the Society of Naval Architects and Marine Engineers..... 362
A Convertible Day, Parlor and Sleeping Car (illustrated)..... 363
EDITORIAL NOTES..... 354
The Increasing Popularity of the Steam Motor-Vehicle—Bookkeeping in the Water Department of Springfield, Mass.
EDITORIAL:
Letting Contracts Without Competition..... 354
LETTERS TO THE EDITOR.....355, 357
Multum in Parvo—Experiments on the Shrinkage of Earth in Embankments—A Fly-Wheel Disaster and its Lessons—Tracklaying on the Kersey R. R.—More Fun with the "Southern Review of Commerce"—Teaching Finance in Engineering Schools—Mathematical Work in Engineering Schools—Were Correct Deductions Drawn from the Bacterial Studies of Pavements at Lafayette, Ind.?—Notes and Queries.

A DOUBLE TRACK BRIDGE SPAN weighing 200 tons and forming a part of the new Spuyten Duyvil Bridge for the New York Central & Hudson River R. R. was floated and landed in position on the masonry piers in remarkably quick time on Nov. 15. The span had been previously erected on scows alongside the south end of the bridge and was all riveted up with the floor system in place and ties laid, read to receive the rails. The span was erected cross-wise of the scows with an overhang of several feet at each end, so that the scows would pass between the piers and, as the tide fell, allow the bridge to drop into its place. The span had to be floated several hundred feet and entered through a rather narrow and difficult channel to its position. The whole operation, including time from starting to move the scows and span to the time of landing the span in position on the piers with the falling of the tide, was about four hours. The rails were laid on the span and the connection with the balance of the bridge and main line was completed two hours later, so that interruption to the railway traffic was only six hours. This span closed the old channel. A new channel now has to be opened through the new draw span, which will incur the removal of a temporary wooden trestle and some dredging. The moving of the span was done by the King Bridge Co., of Cleveland, O., the contractors for the Spuyten Duyvil Bridge, which was fully described in Engineering News of June 14, 1900.

THE BLACKWELL'S ISLAND BRIDGE ordinance has been approved by Mayor Robert Van Wyck of New York city. The Municipal Assembly and Board of Estimate and Apportionment last year passed a bond issue of $1,000,000 to meet the cost of borings and soundings and other preliminary work on the bridge, but the failure to pass the enabling resolution has prevented the commissioner of bridges proceeding with the work. The ordinance signed by the Mayor now removes this abstacle. According to the provisions the bridge when completed will become a public highway between Manhattan and Queens at all times. The position specified is "across Blackwell's Island," and "from, at or near the foot of Sixtieth St., in the Borough of Manhattan, to, at or near the foot of Charles St., in the Borough of Queens."

THE LITTLE BELT SUSPENSION BRIDGE PROJECT, to connect Jutland, in Denmark, with the Island of Fionie, would call for structural work 3,280 ft. long. The actual length of the bridge proposed would be about 2,100 ft., including a central span of 984 ft. The bottom chord of the bridge would be 164 ft. above sea-level; and the cradles for the supporting cables would be 287 ft. above the same level. The estimated cost is $4,050,000.

A JOINT SEWERAGE AND SEWAGE PURIFICATION scheme for Birmingham, Ala., and other cities and towns in Jefferson Co., has been reported on by Mr. Julian Kendrick, City Engineer of Birmingham. The report, which is addressed to the Board of Revenue of Jefferson Co., advises the construction of two trunk sewers and two purification plants, to serve "Bessemer, Birmingham, Avondale, Woodlawn, East Lake, North Birmingham, Thomas, Pratt City, Ensley and the intervening portions of the two valleys." Double filtration is recommended, with the construction and operation of two beds, of an acre area each, prior to the installation of the whole scheme of purification. The estimated cost of the whole improvement is $523,785. A reduction of water waste is strongly advised, as a means of decreasing the cost of the improvements and the operation of the purification works. A bill authorizing this joint work has been prepared for introduction in the next legislature.

ANOTHER SUIT AGAINST WATER POLLUTION has been brought in Connecticut, this time against the city of New Britain. Damages to the amount of $10,000 are claimed by Carrol L. Dudley, of Berlin, as well as the right to an injunction against further pollution. Mr. Dudley claims that since Jan. 1, 1895, the city has discharged sewage, acids and other noxious substances into the Mattabesett River, on which he has a farm and grist mill; that this action has deprived him of the use of the river for domestic purposes and watering stock, has clogged the wheels of his mill and rendered his dwelling house untenable.

SECTIONS 1 AND 2 OF THE CLEVELAND WATER-Works tunnel were joined a few days ago. About 3,600 ft., of a total of 26,000, remains to be driven, according to the local papers. Mr. M. W. Kingsley, M. Am. Soc. C. E., is superintendent of the water-works and engineer of this improvement, which was described at length in our issue of Aug. 11, 1898.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred at Polk, Pa., Nov. 17, on the Pennsylvania R. R. An extra freight train collided head on with a regular passenger train, resulting in the deaths of six persons and the destruction of the locomotives.—In a head-on collision between two freight trains at Hargrove, Ala., on the Southern Ry. on Nov. 18 three persons were killed and three seriously injured. The accident resulted from the engineman mistaking a signal.

THE STRICKLER TUNNEL, for the water supply of Colorado Springs, Colo., has been completed, water has been turned into it, and the litigation between the contractor and the city has been definitely decided in favor of the contractor. This tunnel, which was described and illustrated in our issue of Aug. 27, 1896, was built to obtain a new water supply from lakes on the opposite side of Pike's Peak. The delays and troubles incident to the work, for which the city admitted the contractor was not responsible, were reviewed in our issue of March 30, 1899, and in a further note in our issue of March 15, 1900, it was stated that in September, 1898, the city council had granted to the contractor (Mr. Geo. W. Jackson, of Chicago), a franchise for the right to use water from the city water system to develop power. This was granted as part payment of the city's indebtedness. The granting of the franchise, however, met with strong opposition from the existing power and railway companies, and they secured the passage of an ordinance in February last repealing the ordinance under which the franchise had been granted. Mr. Jackson carried the matter to the courts and the case was decided against him by the Circuit Court of Colorado. The case was then sent to the U. S. Circuit Court of Appeals, and its decision was rendered at St. Louis on Nov. 5. This supports the contractor on every point, and is final as regards the franchise. The decision is given below, practically in full, as it is an important one:

1. The court has jurisdiction to hear and decide the case on all the questions raised.
2. Under the general power to manage and control the property of the city, the city council had power to pass the ordinance of September, 1898 (granting the power of franchise to Mr. Jackson).
3. The repealing ordinance passed February, 1899, is unconstitutional and violates Section 10, Article 1, of the Federal Constitution prohibiting the passage of a law impairing the obligation of contracts and also violates the fourteenth amendment, which forbids the taking of property without due process of law.
4. A city ordinance passed under legislative authority is the law of the State within the meaning of the Constitution.
5. A municipal grant from which neither the city, its citizens nor the public, receive any consideration or derive any benefit is beyond the power of the municipality and is void.
6. A municipal grant to private parties for public purposes is not ultra vires and the city has authority under its general power to grant reasonable rights and privileges so long as such grant does not materially impair the usefulness of such public utilities.
7. The Jackson ordinance was not for a purely private purpose, but was also for a public purpose.
8. The Colorado statute empowering cities to erect water-works, gas works or electric light works, or to authorize same, applies only to works erected by the city or by others under contracts with or for cities and does not apply to works erected by private parties for their own use.
9. In contracting for the enlargement of its water system and electric lights for municipal purposes, the city exercised its business powers and is subject to the same rules of law that govern private corporations, and its contracts bind its successive sets of officers.
10. Public utilities of a city are held in trust for the purposes for which they are acquired and it is the duty of the municipality to supply the surplus capacity or use of such utilities for the benefit of the public.
11. The city under its general powers, has authority to lease to private parties the use of water from its water system where such use does not impair the usefulness of the water or public utilities.
12. The city having first made default in payment of installments under the contract, the courts will not enforce a forfeiture of the contract for delay in performing it by the grantees in the contracts.

BIDS FOR FOUR 30,000,000-GALLON PUMPING ENgines for the new water-works of Cincinnati will be received for the fourth time on Dec. 16. The contract was awarded to the Lane & Bodley Co., of Cincinnati, in 1898, but subsequently cancelled. On the second advertisements the bids were rejected as too high, and on the third they were rejected as not complying with the specifications, although lower than on the second bidding. Mr. Chas. G. Roth is clerk of the board of trustees, "commissioners of water-works," and Mr. G. Bouscaren, M. Am. Soc. C. E., is chief engineer.

A FAST RUN ON THE CANADIAN PACIFIC RY. was made on Nov. 12, with a special train carrying Lord Strathcona from Montreal to Ottawa. The train left Windsor Street station, Montreal, at 8.37 a. m. and reached Ottawa at 10.27 a. m., making a distance of 111.4 miles in 110 mins. It is stated that at least 10 mins. should be deducted from this, however, for slow running through Windsor St. Station yard at Montreal and the Central Station yard at Ottawa, and for reducing speed at four interlocked grade crossings, and at Ste. Annes and Vaudreuil, to receive and deliver the electric train staff. The train consisted of Atlantic type engine 210, one coach and the private car "Metapedia."

THE SITE OF THE ANCIENT CITY OF UR is to be explored by an American expedition, which will sail from New York about Dec. 25, and the services are desired of a young engineer to accompany the party. He must be thoroughly competent in topographical work and of robust health. A man with experience in rough work on the Western plains is preferred. The salary paid will be moderate, but a generous allowance will be made for living and traveling expenses, and to anyone with a fondness for adventure and an interest in antiquarian explorations, the opportunity is a most unusual one. The expedition is backed by a large number of well-known scientists and capitalists interested in original research, and will spend two or three years in excavating the site of Ur and other ancient Babylonian cities. Dr. Edgar James Banks of Columbia University is the Director of the Expedition, and applications should be addressed to him in care of Engineering News.

A BOARD OF ENGINEERS consisting of Col. J. W. Barlow, Maj. J. H. Willard and Maj. Chas McD. Townsend, U. S. A., has been in session during the past week at Chicago, Ill., preparing a report on plans and estimates for the improvement of the Des Plaines and Illinois Rivers between Lockport and La Salle, Ill.

THE FIRST MANHATTAN RAILWAY ELECTRIC train has been placed upon the Second Ave. line for trial. It is made up of four ordinary cars and two motor cars—one at each end. Each of the latter is equipped with four 100-HP. motors; this is equivalent to a total of 800 HP., or four times that of the locomotive now in use. As there is an operating cab at each end of the train, there will be no shifting or delay at terminals, as the train will start back as soon as loaded.

THE MANHATTAN RAILWAY CO., at its annual meeting of Nov. 14, reported, for the last year, gross earnings of $9,950,785, and net earnings of $3,883,088. This is an increase of $671,767 over the net earnings of the previous year. The road carried during the year 183,788,851 passengers, as compared with 177,204,558 in 1899. There was also a decrease of $90,870 in operating expenses. President George J. Gould reported excellent progress on the electrical installation; the heaviest work at the power station at East 74th St. is completed; the superstructure is being rapidly erected and the first machinery is to arrive in December. The first electric train is completely equipped and will soon be operated on the Second Ave. line, with power supplied by the Metropolitan Street Railway Co. The Fordham extension, to 180th St., is nearly ready for trains, and the line will be finished to Fordham in January next. Mr. Alfred Skitt was re-elected Vice-President and Mr. D. W. McWilliams, Secretary and Treasurer.

CEMENT FOR THE NEW YORK SUBWAY is to be inspected at its place of manufacture, at Egypt, Pa., by order of Chief Engineer W. B. Parsons. This is an innovation upon former practice; but it is believed that it will tend towards a more even standard of quality, avoid the storage of large amounts of cement upon the work and prevent the return of rejected material. The cement company is required to provide large storage bins at the works, where the cement will stay a sufficient time to insure its quality before delivery.

A FOOTWAY SUSPENSION BRIDGE WITH THREE TOWERS, AT EASTON, PA.

By H. G. Tyrrell.*

The accompanying drawings illustrate a suspension foot bridge, connecting the city of Easton, Pa., with North Easton. It crosses the Lehigh River, the Lehigh Coal & Navigation Co.'s Canal, and the four tracks of the Lehigh Valley R. R. The difference in elevation of the two ends of bridge is 95 feet. To overcome this a grade of about 7% was used, and four runs of stairs are placed at one end. The canal bank affords a good opportunity for a tower. This was placed on sloping ground, leaving room for an electric railway on the top of bank. It was at first intended to use only two towers, one on the canal bank and another in the river, but on visiting the site the writer found that a piece of ground large enough for an anchorage could be purchased on the further side of Glendon Ave., and accordingly he changed the design, so as to place another tower on the North Easton side. The high ground adjoining the street could not be purchased for a tower site, so the tower was placed on the street as near as possible to the property line. From this tower the cables pass over Glendon Ave., leaving a clear headway of 20 ft. It will be seen that the bridge has the unusual form of a suspension bridge, with three towers. The small width of the bridge in proportion to its length made it necessary to guy two spans to the shore. The anchors on the low end of the bridge were buried below Dock St., keeping the cables clear of the street. It will be seen that the total length of the floor is 668 ft. The versed sine of the cables is 1-10, and the cables are cradled 12 ft. On the two intermediate spans, the lowest point of the cable is 24 ft. off the center of span. The bridge is designed to carry a uniform live load of 50 lbs. per sq. ft. of floor on cables and 20 lbs. per sq. ft. of floor on stiffening trusses. The floor itself is proportioned for a live load of 80 lbs. per sq. ft. The cost of the bridge complete is about $3 per sq. ft. of floor.

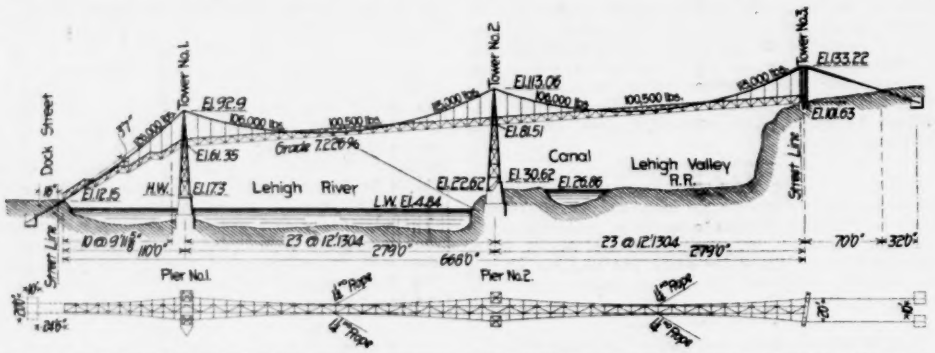


FIG. 1.—ELEVATION AND PLAN OF FOOTWAY SUSPENSION BRIDGE, WITH THREE TOWERS, EASTON, PA.

Boston Bridge Works, Boston, Mass., Contractors.
H. G. Tyrrell, Assistant Engineer Boston Bridge Works, Designer.

The following extracts from the specifications will explain such of the essential details of this interesting structure as are not fully described in Mr. Tyrrell's article:

SUBSTRUCTURE.—The foundation work for the piers and the anchorages is to be extended to such a depth and in such a manner as shall be ordered by the engineer. Where necessary, sheet piling may be ordered to be driven or placed on one or more sides of the work. If the material or excavation is such, in the opinion of the engineer, as to require especial precaution the excavation, piers and anchors may be ordered extended to a depth beyond the indications of the plans.

The foundation for the river pier will be made by means of a crib of size and material, as shown on the drawings. The crib will be framed of square, good, sound 12 × 12-in. hemlock timber of the form and dimensions shown on the drawings. The timbers must break joints at partition points and be secured by ⅞-in. drift bolts driven into ¾-in. holes bored at an angle. The bolts are to be generally 22 ins. long excepting at important interseection points, where they will be required to go through three courses of timber. Screw bolts are to be used whenever required so as to bind the whole mass thorough together. The top of the crib when finished must be at an elevation as shown on the drawing.

The crib will be sunk after the foundation for the same has been properly prepared by dredging the river bed to a depth satisfactory to the engineer, and is leveled off. Rip-rap, consisting of stone of approved size, shall be deposited about the river pier in quantities satisfactory to the engineer.

After the crib has been sunk to its proper position and the top is at the proper elevation, the pockets shown on the plan shall be filled with stone of such size as the engineer may approve. The top of the crib will be covered by a solid flooring of 12 x 12-in. timber, as shown, and the masonry will be laid directly upon it.

SUPERSTRUCTURE.—The floor of the bridge is to be made up of four lines of stringers running lengthwise of the bridge and supported about every 12 ft. by cross beams at each panel point of bottom chord. The stringers are to be firmly bolted to the cross beams by means of knees riveted to the beams. On top of stringers will be laid two courses of ⅞-in. planking, the first course to be laid diagonally across the bridge, and the second course to be laid directly across, both courses to be fully spiked to stringers and to each other.

To give stiffness to the bridge, there are to be two trusses which shall be made of same section throughout, as shown in one panel in the detail drawings. These are supported by hangers from the cable above and are to be rigidly attached to the floor beams. The bracing between the trusses is to be continued their entire length, as shown on the plan for one panel, and braces from the ends of floor beams to the top chord of the trusses shall be attached in a rigid manner so as to give all the stiffness possible. All this material, including floor beams, shall be medium steel.

The hangers shall be made of best double refined iron, with a turnbuckle in each to permit adjustment. The cables shall be composed of six strands with a wire center, shall be galvanized, and shall be of equal tensile strength to those manufactured for suspension bridges by John A. Roebling's Sons & Co. The towers shall be anchored to the masonry by bolts bedded in same.

One end of the bridge is to be made with alternate short flights of stairs and landings. The stairs must be supported on stringers in such a manner as not to weaken the stringers, and 1¼-in. tread and ⅞-in. risers are to be included. There shall be a fence provided, to consist of two lines of wood attached to the trusses as indicated on the drawings. The cables are to be attached to I beams bedded in a block of masonry.

All structural steel not otherwise specified shall be medium steel; all melts must be of uniform stock in which phosphorus shall not exceed .08%. The work throughout shall be in accordance with Theodore Cooper's General Specifications for Class A, Iron and Steel Highway Bridges, New and Revised Edition, 1890. The rivets shall be made of steel in accordance with these specifications.

The accompanying drawings, Figs. 1 to 7, show the principal structural details of the bridge. Fig. 1 is a general diagram elevation and plan of the bridge. Fig. 2 shows the anchorage construction for the lower end of the bridge, that for the upper end is the same except that each cable has a separate anchorage. Fig. 3 shows the details of tower No. 2; Fig. 4 is a transverse section of the bridge showing the floor construction, and Fig. 5 is a detail showing the manner of attaching the hangers to the floor beams. Fig. 6 shows the construction of the cable sockets, and Fig. 7 is a detail of the clamps used in attaching the hangers to the cables.

*Assistant Engineer Boston Bridge Works, Boston, Mass.

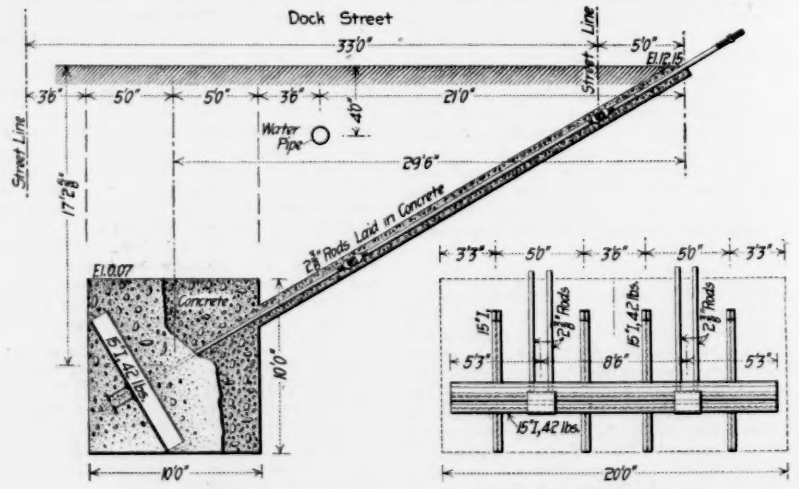


FIG. 2.—DETAILS OF LOWER END ANCHORAGE, EASTON, PA., SUSPENSION BRIDGE.

NOTES ON RECENT IMPROVEMENTS IN FOREIGN SHIPBUILDING PLANTS.*

By H. G. Gillmor.†

Among foreign shipbuilders, as among other manufacturers with whom America is in competition, the impression seems to be general that American plants and American tools are as far in advance as those of any country in the world. Having come, unconsciously, to accept this view, it was with some surprise, not unmixed with misgiving as to the possibility of presenting anything worthy of the Society's attention, that the Secretary's request for a short paper on this subject was received. If, then, what follows lacks in interest, attribute as much as may be to the limitations of the subject. It is based upon observations made during visits to foreign shipbuilding yards during the years 1891 to 1894 as compared with those made during recent visits in the years 1898 to 1900.

Of the general arrangement of plants there is not a great deal to be said. Many, if not most, plants have been developed from modest undertakings of individuals, their arrangement, in the first instance, being dictated by the character of the ground and the means at command. In expanding to meet the requirements of increasing business, the best possible, under the circumstances, has doubtless been done; but in few cases is the arrangement the best possible with the given space, nor that which the responsible heads would have made had they been able to lay it out in the beginning on the basis of the present business. The increasing size and length of vessels ordered has, in many cases, forced a re-arrangement of yard and plant, and in all such re-arrangements the working shops have been brought as near as practicable to the ships, and an effort made to make it possible for the material in preparation for the ship to follow a more or less regular course through the shops with as little handling as possible.

In connection with the arrangement, it may be pointed out that the effect of trades-unionism is nowhere more to be seen than in the development of shipbuilding plants

*From a paper read at the eighth general meeting of the Society of Naval Architects and Marine Engineers, held in New York, Nov. 15 and 16, 1900.

†Assistant Naval Constructor, U. S. Navy.

in England. Practically all the steel work about a shipyard is paid for by the piece, and the resistance of what is known as the Boiler Makers' Society, a combination of all the iron and steel workers of the shipbuilding and boilermaking trades, to all reductions in piece prices, is so great, and their power is so felt among the shipbuilders, that it is impracticable to secure any adequate reduction in the cost of labor from improving the facilities for carrying on the work. It might be argued that it would be in the interest of the shipbuilder to improve facilities, in order to increase the output of his plant, even though he should get no direct return through reduction in cost of production. Unfortunately, it is too often the case that

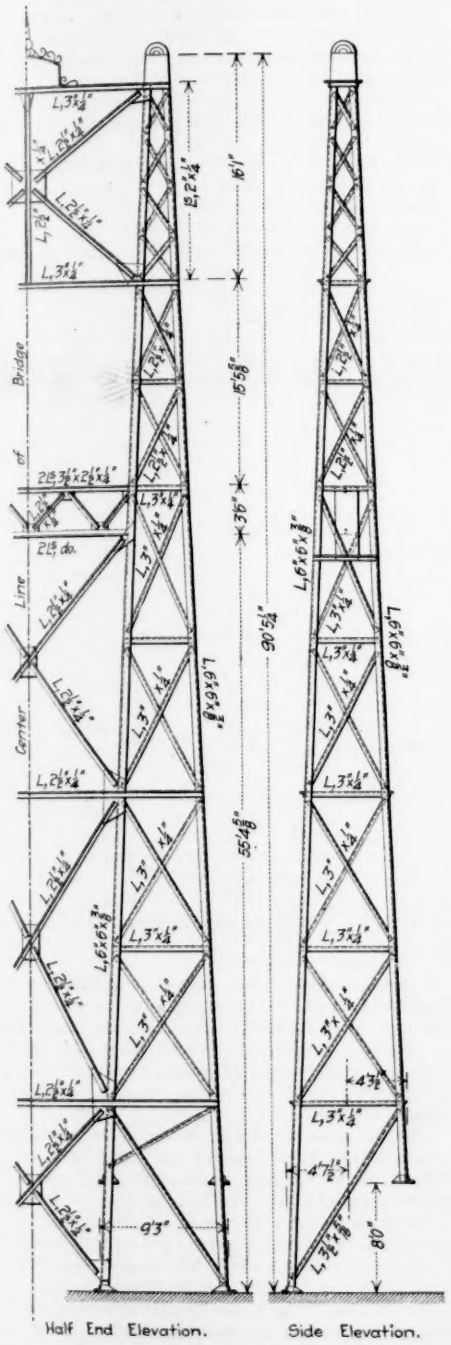


Fig. 3.—Details of Tower No. 2, Easton, Pa., Suspension Bridge.

not even this return comes to the enterprising shipbuilder who improves his plant, for the broken time from which they suffer so much increases with the possibility of increase in earnings of the skilled artisans of the shipbuilding trades. This should be borne in mind when considering the advances made by English shipbuilders, for there are many enterprising ones who would have gone much farther in their improvements had the conditions been such as to make it possible to get any adequate return for the expenditure required. What has been said of the effect of trades-unionism does not apply to the same extent to German yards, and, as a rule, perhaps also partly through their being newer, one finds in them better arrangements and more labor-saving appliances.

There was probably no form of industrial plant more wasteful of power than the average shipbuilding plant of ten or twelve years ago, when, ordinarily, steam was generated in one or more centers in the yard and distributed by a more or less badly kept system of piping, very wasteful at best, and only too often in difficulties. The most striking features in what has been done in this direction is the increasing tendency to do away with the steam-engine and the piping system necessary to its use. Its place, for many purposes in the shipyard, is being taken by gas or oil engines and by electric motors.

There are few foreign yards to-day in which the gas-engine is not to be found doing work which was formerly done by the steam-engine; and, in at least one large and important yard, steam has practically disappeared except for the hydraulic pumps and the yard locomotives. The municipal gas companies, in nearly all cases, supply illuminating gas for fuel and power at a somewhat reduced price. In many cases, however, some form of low-grade fuel gas is made on the premises for gas-engine consumption. The managers of these yards in which gas-engines are most extensively used express themselves as well satisfied with them as mechanical agents. They point out also the very great advantage which they derive from the saving of space by the doing away with steam generators in those cases in which illuminating gas is used, or the relegation of the smaller gas generators used in other cases, to the least valuable and useful space in the yard. In this connection it may be mentioned as a sign of the times that in one important German shipyard a considerable portion of the power of the shops is supplied by a pair of large Diesel oil engines.

While the gas-engine serves very well for many purposes about the shipyard, it is not adapted to the direct driving of the several heavy machines, subject to more or less intermittent working, which have so prominent a place in a shipbuilding plant. In connection, then, with the changes in which the steam-engine is supplanted by the gas-engine for some purposes, it is not surprising to find its place, for other purposes, being taken by the electric motor. In the general industrial applications of electricity we are, in this country, well in advance of the old world; but in its application as a medium for the transmission and distribution of power in a shipyard, a great deal is being done abroad.

There are numerous examples of electric motors having taken the place of steam-engines for driving all the heavy and fairly widely separated tools of the plating shops. The motors have shown themselves capable of working continuously or intermittently for long periods with, at any rate, not more attention than is generally required for steam-engines employed for the same purposes, and provided with no other protection from the weather and the dust than a light wooden box or house with end panels of finely perforated tin or iron gauze. It may also be mentioned that it has been found practicable to place the care and management of the wiring and motors in the hands of men, in some cases apprentices just out of their time, whose wage certainly would not entitle them to be designated highly paid specialists.

Hydraulic power is to be found in practically every yard in which vessels of any size are built. It is employed for the heavy flanging machines and manhole presses, and in many cases for operating the smaller cranes used in handling the heavy work at the machines.

Toward improvement in appliances for handling materials at the ship, with perhaps two notable exceptions, little has been done in recent years. Comment upon this fact usually elicits the reply that it is useless to provide the workmen with facilities which render the handling of plates, etc., at the ship, easier when it is not possible correspondingly to reduce the piece price paid for doing the work. In most cases a series of wooden derricks, distributed along the two sides of the building slips, with a winch each side at the head of the ship, to which whips or purchases may be taken, are regarded as sufficient to meet the requirements. In defense of the system, as compared with other and more elaborate arrangements for handling material, it is also urged that by far the greater number of individual pieces which have to be placed are of such moderate weight that the appliances at present provided are fully capable of doing the work, and that to have a number of such, to all of which work may be brought simultaneously, is preferable to employing some form of traversing crane or derrick. Light locomotive cranes, which may be employed both for handling cars in the yard and for picking up and transporting considerable weights, may be found a part of the equipment of many yards.

The standard shipyard tools abroad have suffered very little, if any, change in type for years. The increase in scantlings, with the ever increasing sizes of ships, has made an increase in size and power of these machines necessary, and at the same time their speed has been materially improved. The frame beveling machine, an English invention, while in almost general use in Germany is used to a much smaller extent in England. A plate joggling machine for joggling edges and butts, and so doing away with liners for the raised strakes, has come into very general use in England. There are also some very ingenious plate scarping machines in use where lapped butts are worked. New and special designs of plate drilling and countersinking machines, rolls, etc., are also fairly numerous.

Of the tools of the so-called fitting shops and the joiner shop it may be said that, in a general way, the improved tools adapted to the work of each have been introduced to a moderate extent, and it is gratifying to Americans to find that in these shops many of the newer machine tools

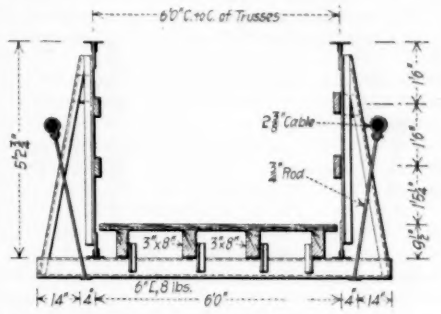


Fig. 4.—Transverse Section Showing Floor Construction, Easton, Pa., Suspension Bridge.

are of American manufacture. In many foreign yards a great deal of work, which would otherwise be done in the fitting shops, is let out to concerns making a specialty of that sort of work, so that the fitting shop becomes less important than it would otherwise be.

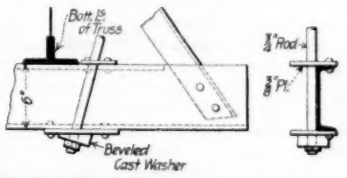


Fig. 5.—Detail of Hanger Attachment to Floor Beam, Easton, Pa., Suspension Bridge.

In the employment of portable tools at the ship very little has been done. There are considerable numbers of portable electric drilling and countersinking machines in use even in some yards in which electricity is not employed for other purposes. Portable hydraulic riveters

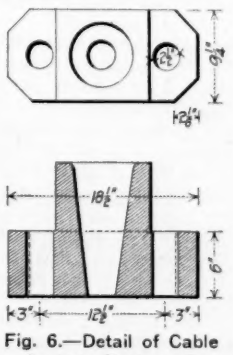


Fig. 6.—Detail of Cable Socket, Easton, Pa., Suspension Bridge.

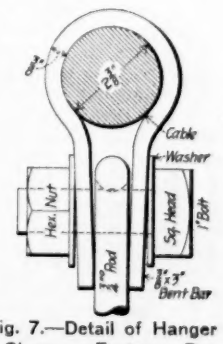


Fig. 7.—Detail of Hanger Clamp, Easton, Pa., Suspension Bridge.

are also employed to a considerable extent for riveting up frames, floors, and longitudinals, generally at the building slip itself. Portable pneumatic tools, however, although used to a considerable extent in boiler shops, have thus far found an extremely limited adoption in the shipyards.

THE CENTER OF POPULATION IN THE UNITED States has not moved very much westward, say those in control of the census of 1900. In 1890 this center was near Greensburg, in Southern Indiana and it is now only about 50 miles due west of this same point. In 1790 this center was on the Eastern Shore of Maryland, almost opposite Baltimore, and it advanced by considerable strides with each decade almost in a due west line, with a slight tendency southward up to 1860. But the census of 1900 shows for the first time, that to the east of a line drawn north and south through Grensburg the population has gained rapidly on the newer western sections. On a line drawn east and west through Greensburg, of the aggregate gain of 13,235,000 since 1890, fully 7,500,000 are found north of this line; this will make the true center of population considerably north of Greensburg. The great increase is in the urban population of the northern cities, as more than 2,750,000 of the gain north of the line mentioned is in 17 chief cities; while the cities south of this line show a gain of only 375,000, St. Louis alone shows 123,000 of this latter gain, and Baltimore is excluded as being practically on the line. Fourteen states contain 47,153,023 people out of the total population of 76,295,220; and two-thirds of the increase are in the old free states.

SPIRIT LEVELS ON ENGINEER'S FIELD INSTRUMENTS.

By Harold Van Duzee, C. E.*

In what may be termed commercial field work, corps precision is always a source of long and lively discussion, and the more corps the merrier the discussion: "We checked our circuit to twenty-five hundredths. Is not that pretty good on a hot day?" Then comes the long discussion of—Why not closer, and how close is possible. In recalling many such talks, no single instance comes to mind when the sources of error were positively stated, the principal excuse given for the failure to do more exact work being generally, "well, you know that no two men ever hold the rod just alike," and this passed as deep wisdom.

Much experiment and experience has convinced the writer that the instrument man, the instrument, the rodman, and the rod, all contribute to the lack of precision; and for perfectly plain reasons in the main, reasons that are carefully reckoned with by specialists, while not nearly so well understood and appreciated as they should be by the instrument man; nor does the writer remember having seen any popular treatise covering this point in engineer's field work.

It is proposed here to discuss one instrumental defect that is very active, but is apparently hardly thought of by large numbers using or owning field instruments, only the most expert operators appearing to give the matter attention in what is known as precise work; reference is here made to the reliability of the spirit levels attached to transits and levels.

The best makers of these instruments take special pains in the manufacture of the vials, carefully selecting the glass and grinding its interior surface to a true curve in order that the bubble shall expand equally on either side of the center as the temperature changes; they adopt certain dimensions of vial, and select certain fluids which seem most likely to bring the best results; but this care of the maker by no means renders needless the intelligent use of the levels in the field.

Most instrument men are satisfied if the bubbles show true on reversal after adjusting without once thinking that the vertical axis might be a full minute out of plumb at the same time; such a vial is entirely unsuited to a good instrument, and might make but a poor carpenter's level. When using telescopes possessing a line of collimation leaving little to be desired, and that will point easily to a target with an error of from half a second to a second, it is evidently desirable that the pointing should be well governed, and that the governing should be well understood, otherwise the full value of the instrument is not realized.

The investigation about to be described was occasioned by the continual difficulty of keeping transit levels in adjustment, and the inability of an otherwise very convenient instrument to give the accurate work to be expected from it. As usual these difficulties were not understood; often the levels seemed out of adjustment when they were not so, but were merely in a state of change, as will be shown further on. Especially was it noticed that the results of angular and direct leveling were not so close as might have been expected from the care taken in observing.

This induced a little investigation, showing that a change in pointing of but two or three seconds was easily detected on the target; it was then thought that a more sensitive telescope level would govern this pointing satisfactorily, so the vials were changed several times, with the result of making the instrument more fidgety and without improving the work. Although adjustments held well in the shade, in the sun they were always out; finally, in the desperation born of ignorance, an attempt was made to adjust a very sensitive level in the sun, but utterly without success.

This was convincing that the bubble was subject to a more or less rapid and continuous change, irrespective of the balance of the instrument, and the following-described rather crude experiments were made by the writer to demonstrate the fact more clearly, and also to determine the relative merits of some new vials. The scheme was to determine the relative stability of the line of sight and the position of the telescope bubble under varying conditions of exposure to the direct rays of the sun.

For this work a convenient line was selected, 89 ft. long, at which distance 0.001 ft. on the rod was equivalent to 2.3 seconds of vertical arc. By using a specially-designed target a movement of less than a thousandth could be easily detected, and it is believed that the target was set within about one second of arc at each pointing.

The direction of the line was about N. 50 deg. W. from the instrument station. The rod was firmly secured in a vertical position, and rested on a screw head in the top of a stake. A second rod was similarly placed close to the observing station for the purpose of checking the height of the instrument, and it might be stated here that no change in the height of the instrument could be detected, although it was carefully looked for. The instrument was protected from the sun by a large field umbrella.

The instruments used in the test were a dumpy level of fine capability, and of about 35 power glass, and a transit with a 4-in. plate and a 14 power glass. All had inverting telescopes and were carefully adjusted in the shade. Repeated trials showed positively that the pointing capacity of the telescopes was within one second of arc, and the various bubbles used would mostly govern the pointing to about two seconds of arc or less. The transit telescopes were provided with gradienter screws. The level and large transit were used for the examination of only their own vials, attached to telescopes, while a number of smaller vials were examined under the telescope of the smaller transit.

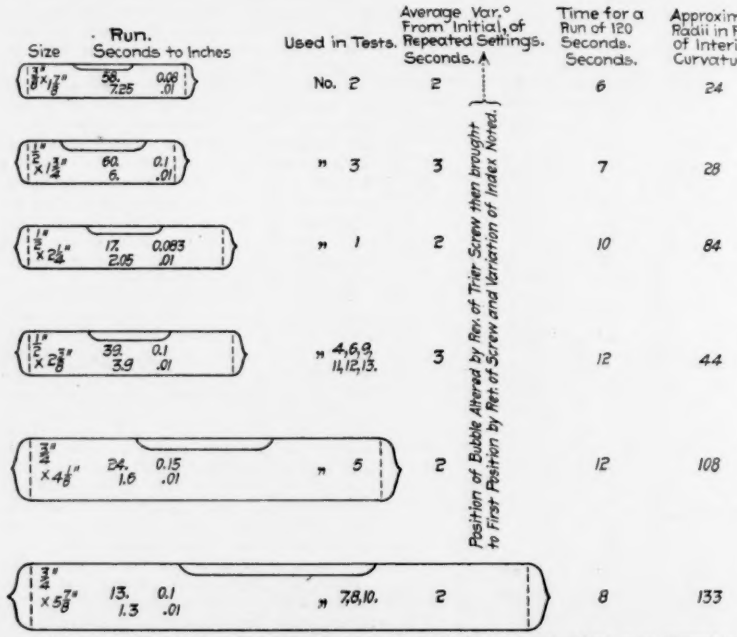
The instrument to be used was kept shaded from the direct sunlight till set up, and an initial pointing was made and recorded; it was then exposed to, and sheltered from, the direct sunlight from time to time by using the large field umbrella. Under these varying conditions the bubble was brought to its center and the target immediately set to the line of sight and records were taken, as shown by the accompanying diagrams. The motion of the sun sufficiently varied the direction of the exposure, and its duration was governed by the umbrella. The work was done in a rather random manner, largely owing to ignorance of what to expect, and there was no thought of making the work public until much later, when the interest and advice of a few engineers made the idea seem reasonable.

The accompanying chart gives the essential facts about the vials used and the numbers serve to identify them with the diagrams of examination. The time scale, used in plotting, changes where it was found that longer tests were desirable.

Test No. 1 shows that the bubble "had a step of its own," in that it changed the pointing about 28 seconds in an hour's time and then changed back again; this was a very sensitive bubble, quick and true, according to the level-tester, when under cover, but evidently useless out of doors. Although more frequent observations might have developed a more interesting line on the diagram, its evident unfitness for field use saved it from further attention.

Another vial of somewhat similar character, beautifully accurate on the level tester, reading about 25 seconds of arc for two millimeters of travel, was so unsteady out of doors that it was impossible to obtain an initial pointing, so no record was made; its size corresponded to that used in test No. 2.

Test No. 2 shows another very unstable bubble. A very interesting effect of direction to exposure, to be noted, is that when the sun is about at right angles to the line of sight, the bubble and mounting are more evenly affected throughout, causing



VIALS USED IN TESTS TO DETERMINE EFFECT OF SUN ON INDICATIONS OF SPIRIT LEVELS.

the slow return of the bubble to a more normal position relative to the balance of the instrument, so that in this case the line of change undoubtedly would have continued to go down had not the shade been placed at 27 minutes past one o'clock, after which there was a fairly steady pointing for nearly an hour.

The direction of the change (up or down) and the rate are very marked upon the removal or application of the shade, as can be noted by a glance at any of the records.

An interesting side result of these tests was noted in the amount of motion of the telescope from any pointing when left undisturbed in the sun, amounting to 130 seconds in test No. 3.

In test No. 2 the sun was pointing towards the eye-piece, causing an upward pointing of the telescope, while in test No. 3 the sun was shining towards the object end, causing a downward pointing, and this effect, resulting from the direction of exposure, may be generally expected.

Test No. 3 was made with the plate vial of a high-grade instrument and shows a change of pointing of 25 seconds, and the tranquilizing effect of shade. It also shows that in regaining even conditions, while shaded, the bubble may create an error in the opposite direction.

Test No. 4 shows a rather perplexing line of pointing, especially during the application of shade; the action of this bubble was more sluggish than that of the preceding ones, and this may have caused defective observing to the extent of perhaps 6 or 8 seconds. The changes while pro-

*427 Walnut St., Philadelphia, Pa.

tected from the sun were slight, but on exposure, the change of pointing was immediate and upward. This is the first test showing anywhere near the rapidity of this change, the last observations being about six minutes apart, and showing a rate of change approximating 2 seconds of pointing to the minute of time.

Test No. 5 was with the large transit, and shows a rate of change of 1 2-5 seconds per minute. Besides the applied shade, the bubble had protection from the sun by the telescope, while the sun was passing the observing line; had it not been for this, the line of change during exposure would have shown greater variation.

This bubble was very sensitive to slight heat changes. A number of times it was seen to change position slightly on taking the head from the eye-piece. The instrument being firmly planted, the only cause for this motion seemed to be the heat of the observer's body.

Test No. 6 shows a rate of change of about 2 seconds of arc to the minute of time, and also the decided effect of the sudden brightening of the sun. It also shows that the umbrella is not a thorough protection, the sun exerting some influence during the applied shade.

Test No. 7 was made with the dumpy level fitted with the largest vial tested. The initial observation was recorded before the station had received the direct rays of the sun. The first change of 15 seconds may have been due to a change of temperature of the instrument after leaving the case, as after that the pointing was fairly steady, the use of the umbrella producing but slight effect. This instrument, being designed for leveling, was properly capable of the superior results shown.

Test No. 8, with the same instrument, shows distinctly the influence of direction, as the pointing was higher with the sun towards the eye-piece than when towards the object glass. The amount of change is slight, being less than 10 seconds in over six hours of continuous exposure.

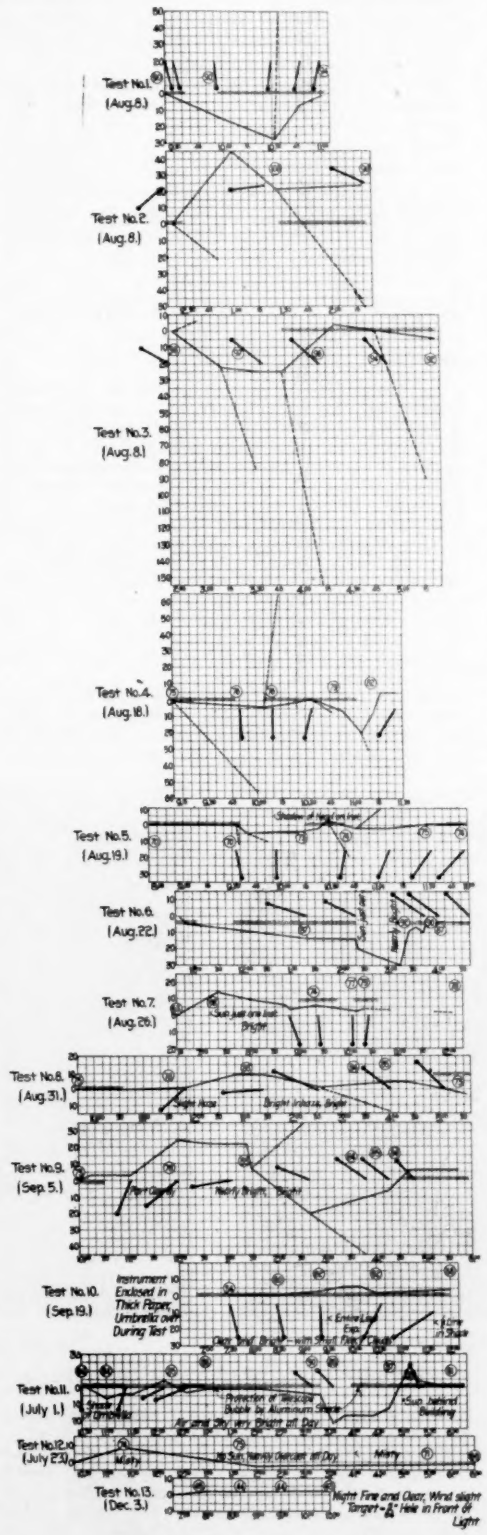
Test No. 9 very decidedly shows the effects from varying directions of exposure. The sun towards the eye-piece causes a pointing up of about 24 seconds, and when towards the object glass the pointing is down about the same amount, and is correct only for a short time while the sun is normal to the line of sight. The modifying effect of shade, either from clouds or umbrella, is very marked.

Test No. 10 was made to verify the conclusions to be drawn from the preceding tests, and to determine the stability of the line of sight. For this purpose the dumpy level, which had proved the most steady instrument for this work, was wrapped loosely in a double thickness of stiff manila paper, having a small opening on the side for the inspection of the bubble, and at each end for sighting; umbrella shade was maintained during the entire test, so that the instrument should be well protected from the direct influence of the sun. The temperature change did not exceed 4°. In comparison with preceding tests, the pointing was markedly steady, the maximum variation for twenty minutes being but 6 seconds of arc.

It is the belief of the writer that the pointing was steady to within, perhaps, 3 seconds, and that the balance of the variation was due possibly to slight changes in the line of sight itself, as at times it was partly shaded, and it might have been influenced by adjacent brickwork. The difference between the results of this test and those of the preceding is so great that it may be safe to assert that the curious changes noted are due largely and directly, to the influence of the sun on the exposed levels, and that these changes are mostly independent of any change in the rest of the instrument.

Test No. 11 was made on the theory that the bubble "had a step of its own," that is, was guilty of changing independently of the instrument carrying it. A shade of very thin aluminum, about 1¼ ins. wide, was placed between the telescope and its level, and extended the length of the mounting. A slight touch would move the shade to either side into the direction of the sun. By this device the bubble was well protected, while the remainder of the instrument was fully exposed. The test was made with the small transit and the diagram of pointing shows a most decided improvement over the preceding work with the same vial, the pointing being very steady for four hours and comparing favorably with that of the dumpy level.

The removal of the aluminum shade for about 35 minutes created a disturbance of pointing that took an hour and a-half to recover from after replacing the shade. On other occasions in regular practice the quieting effects of this shade have been very marked, the bubble staying where put when protected, and when exposed, as in ordinary use, the bubble would not stay in one position 30 seconds at a time.



——— Shows Pointing of Telescope, Measured in Seconds of Arc, below or above Initial Reading on a Fixed Vertical Rod.
- - - - - - - Shows Movement of Telescope in Vertical Arc between two Successive Readings, Observed only where Shown.
Indicates Time during which Instrument was Sheltered from Sun by a Large Umbrella.
——• Indicates Approximate Angle of Sun from Line of Sight, Assuming this Line to Point to Top of Sheet.
○ With Figure Enclosed shows Reading of Fahrenheit Thermometer in Shade.
Five Second Intervals of Vertical Arc are Shown by Vertical Spaces.
Line of Sight 89 ft. Long; hence 0.001 ft. on Rod Measured 2.32 Seconds Vertical Angle.
Target Black with White Cross-Bar giving a Field of 12 Vertical Seconds to be Bisected by Telescope Wires cutting about 6 Seconds.

Graphical Records of Tests of Spirit-Level Vials.

Test No. 12, as might be expected, shows but slight variations of pointing during cloudy or misty weather.

Test No. 13 was to show the difference between observations made in the daytime and those made at night; for this the instrument had been left out of doors for some time before using, as was the case in a few other tests.

It is entirely probable that if the work of this test had been correctly done the pointing would have been the same at each of the seven observations; at first there was some difficulty in properly placing the light for the examination of the bubbles, and this may have caused error in the first pointing.

A 5-64-in. hole was drilled in the regular target and the sides blackened. Although larger than needed for this purpose, this hole served to set the target to 0.0005-ft., equivalent to 1.16 seconds of arc. The sighting was to an ordinary light placed behind the hole in the target.

It was interesting to note that a deck level, reading 25 seconds to a division, showed slight changes at nearly every pointing, having an entire range of 30 seconds. These changes were most marked during the observations, and were probably due to the heat from the observer and to that from the small lamp used at the time of pointing. The telescope bubble showed changes not exceeding 3 or 4 seconds.

In general it may be said that if there were any distortion of the line of sight, test No. 10 would show it to be limited to a few seconds in its effect on this work; and, as the 4 ft. of wooden rod used would alter in length not exceeding 0.0001-ft. for 10° change in temperature, it must be that the marked changes in the pointing as governed by the telescope bubble are due to some other causes located at the instrument; and if the decided improvement gained by the use of the umbrella does not sufficiently indicate that the bubble is the chief culprit, then test No. 11, where the vial only is protected by an aluminum shade, should be convincing.

No doubt some one is asking what is the use of this curious information. To this it should be said, that in the present time when engineering feels the prod of fierce commercial methods, the information gained may seem of small moment at first, but it is safe to assert that any increase of knowledge as to the tools of one's profession can be the source of practical advantage to both the designer and the user of these tools.

This investigation seems to show with regard to our field instruments and their use:

1. That when stationed in the sun, the instrument is nearly always on the move with a speed that can be measured by short intervals of time; for this reason the entire field apparatus should be designed for rapid and easy pointing and reading. The instrument should not require time for pointing due to the spring and give of the tangent screws and clamps. Targets should be easily bisected (not covered up) by the cross wires at any distance. Verniers and markings should be so clear and precise that no time need be taken to settle doubts as to the correct readings. The construction of the instrument and tripod should be firm so that the observer will not have to wait for each passing gust to subside in order to make the pointing.

2. The temperature changes affect the bubble much more rapidly than they do the rest of the instrument, and probably much more unevenly, so that in the sun there are continual independent changes that quite prevent the successful reversal of the instrument under all conditions, even when in the best of adjustment. At such times adjustments should not be altered, but can be verified after the instrument has been in the shade for an hour or more. Adjustments should only be made in the shade, or on a cloudy day, or better at night when there is but little wind; and always in a temperature as nearly as possible like that prevailing at the given season. The adjusting lines need be but a few hundred feet long over grass or

cultivated ground; this is to avoid errors that may arise from a slight bending of a long line of sight in passing through different conditions of air.

The instrument thus adjusted under known and steady conditions, is, if a good one, likely to hold the adjustment for subsequent similar conditions, while if the adjustments be attempted in the sun, there is but little chance of satisfaction.

3. In ordinary leveling, the bubble seldom gives the instrument a correct position, excepting in steady shade, and this is one of the reasons why common leveling so seldom "checks out." Even the great rule of even back and fore sights cannot correct this defect, as the line of sight with the bubble central, is likely to point either slightly above or slightly below the horizontal with reference to the direction of the work as a whole. This error is dependent on the position of the sun relative to the line of work and is apt to be cumulative. A partial remedy for this defect is for the observer to stand between the sun and the instrument, so as to give it the benefit of a little shade, and to make the pointings and readings quickly before the level has a chance to alter much.

4. Other things being equal, the action of the bubble improves as its size, especially its diameter, increases; this is well shown by the diagrams, where the two larger bubbles give the best results, even though very sensitive.

It is believed by the writer that much depends on the kind of glass and fluid used in the manufacture of the vials, as well as on the quality and accuracy of the grinding. In fact, he has made tests that showed great variation in the accuracy of the grinding, as in the case of a plate vial that showed for one division of the scale an angular motion of 80 seconds, and for the corresponding division at the other end a motion of but 40 seconds of vertical arc. As this bubble would show a change in the vertical axis of 5 seconds, it will be readily seen that its adjustment would only hold in one temperature, owing to the unequal expansion of the bubble on either side of the center of the graduated scale when the temperature changes; these changes may be sufficient to cause a very appreciable error in the position of the vertical axis of the instrument, while the bubble shows a good position all the time.

5. As some of the tests showed a better service of the bubble when somewhat protected from the sun by the telescope, it would seem to approve the common practice of placing the vial mounting beneath the telescope.

6. The precision with which these pointings were made was only possible through the type of target used, and although this has but little to do with the matter under discussion, it has always seemed that the targets in common use were defective in design, in that the center line of the target is easily covered by the cross-wires of the instrument so that the target can be moved a measurable distance on the rod and still appear to be correct. This is because the cross-wire occupies several seconds of field, and it takes but a short distance from the instrument for this to cover an appreciable space on the target.

Surely it is easier to at once bisect a space and take that reading before the instrument has had time to change, than it is to bother with taking the mean of several readings, as is sometimes done where close results are aimed at while using the ordinary design of target.

The above account of experiments, with the explanations and conclusions taken from them will serve a good purpose if it makes the instrument-man better acquainted with instruments and their uses, and also, if it places the purchaser and manufacturer on a better understanding as to the requirements and possibilities in the construction of these expensive and most useful instruments.

LAUNCH OF A CRUISER AND A BATTLESHIP.*

By James Dickie.†

(With two-page plate.)

The object of this paper is to describe the launching of a cruiser 344 ft. long, 52 ft. wide, with a launching weight of 2,400 tons, and of a battleship 348 ft. long, 69 ft. 3 ins. beam, with a launching weight of 4,100 tons. Before describing the launch of these vessels, however, a brief description of the slips on which they were built will be necessary. Where these vessels were built was a mud flat covered only at high tide, the mud ranging from 70 to 85 ft. deep to hard pan. This entire flat was piled as shown by Fig. 1. The piling is of Oregon pine from 70 to 80 ft. long, and from 14 to 18 ins. diameter at the butt. Most of the piles went to hard bottom, and each pile will safely support a load of 20 tons. The capping on top is 12 × 12 ins.; joists 4 × 12 ins., spaced 24-in. centers; planking 4 ins. thick. (There are heavy joists under the keel and bilge ways.)

The first point to be determined in launching is the weight per foot of surface. The builder uses his experience as a guide in making the selection. The writer has launched successfully at 1½ to 3¼ tons per foot, so that there is a wide range for selection. Should from one to two tons per foot be decided upon, soft tallow will be required to insure success; should two to two and a half tons be selected, the tallow should be medium; should two and a half to three tons be selected, the tallow should be quite hard, and over three tons will require almost pure stearine. The quality of the tallow is also affected by the temperature, so that no hard and fast rule can be laid down. As the temperature is so regular on the Pacific coast the builder has little anxiety about his lubricants. After long experience I have seen nothing that can be depended upon so well as tallow and soft soap. After launching over 100 vessels, none of which required to be started, and only three of which went slowly for the first 50 ft, owing to too much surface in proportion to weight (or too hard tallow), I have implicit confidence in tallow and soft soap.

Next, as to inclination: The writer has used 1 in 14 for small vessels, and 1 in 24 for large vessels, with ways laid concave and convex according to circumstances, and found no difficulty; so that in inclination there is also very great latitude, where cost does not enter into the problem. As the laying of ways cost so much per foot in length, the builder will make them as short as possible consistent with safety. Launching curves are prepared to determine the length of ways necessary, so that the strain on the bottom will not be too great before the vessel is water borne at the after end, and also to determine the strain on the forward poppets when the vessel lifts aft.

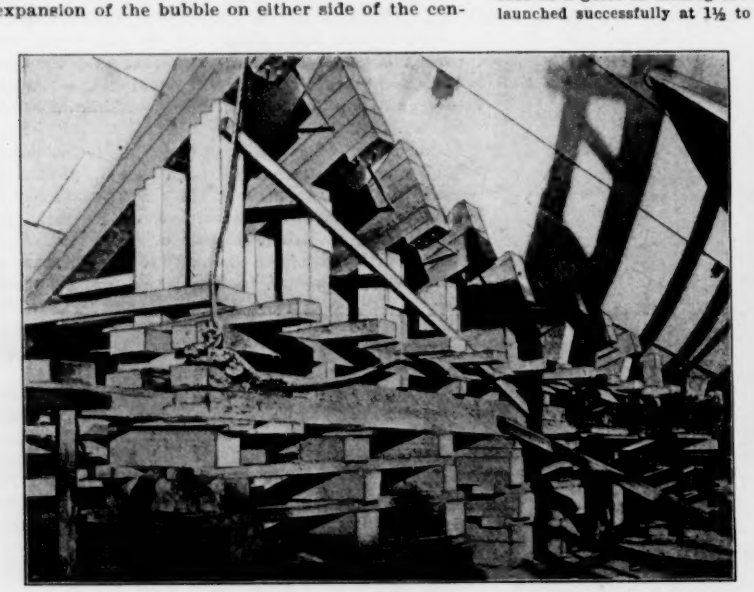
As the launches of the two vessels were somewhat different, we will treat them separately.

LAUNCHING OF CRUISER.

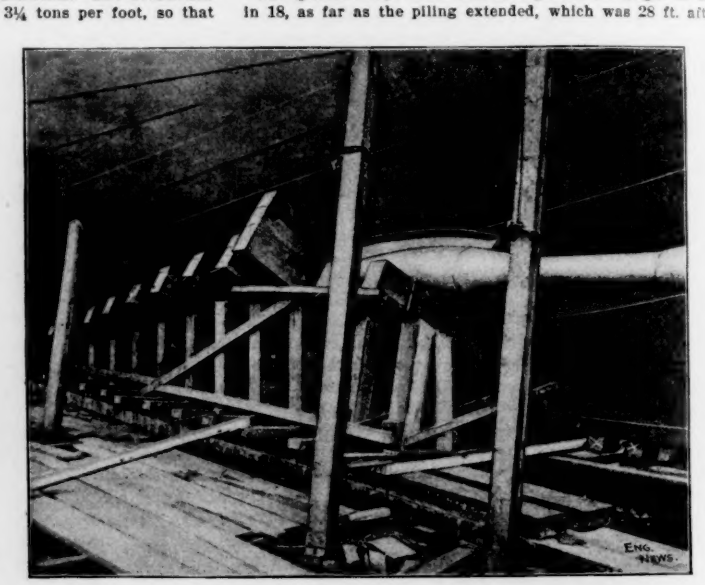
The keel of the cruiser was laid at an angle of 1 in 20, with the bottom of stern-post 14 ins. above high water (Fig. 2). The keel blocks were spaced 5 ft. centers, with four bilge blocks and 28 shores on each side, thus giving an average of 18½ tons to each block and shore. The blocking under the ways was spaced 5 ft. centers for two-thirds the length of the sliding ways at the upper end. The remaining one-third, and for about 20 ft. aft of the after end of the sliding ways, the blocking was spaced 2½ ft. centers; from thence to the lower end about 5 ft. centers. Each block was made up on top with pieces of soft board and shingles, so as to equalize the weight and be somewhat elastic. Our custom is to lay the ways in this manner, and the writer has never seen any smoke nor the grease rubbed off in launching. The ground ways were of clear Oregon pine, without heart (to prevent warping), 18 ins. wide by 10 ins. thick and 60 ft. long, lapped together at the ends 8 ins., and fastened with two ¾-in. bolts (Fig. 3). The sliding ways were of clear Oregon pine without heart, 8 ins. thick by 18 ins. wide, except the lower piece, which was 10 ins. thick. They were in five pieces; the three upper pieces were fastened together with plates on each side, 5 ft. 6 ins. long by ½-in. thick, fastened with ¾-in. bolts. The two lower butts were fastened with wire ropes. The ribband was bolted on the inner edge of the sliding way, projecting down 2½ ins., of Oregon pine 3 ins. thick, fastened with ¾-in. bolts, spaced 5 ft. centers, having plate washers extending down to the lower edge to prevent splitting should any strain come on it.

The ground ways were laid straight at an angle of 1 in 18, as far as the piling extended, which was 28 ft. aft of the heel of the stern-post. From that point 73 ft. further out, the mud was planked over with plank 24 ft. long by 6 ins. thick, laid crosswise. At the outer end this was so high that the point of the ways was 19 ins. above a straight line, which the vessel straightened out without difficulty. This platform on mud makes an excellent ending for ways, should they be short at the lower end. It will settle enough to take the strain off the bottom of the vessel, and being planked crosswise the ways have no tendency to spread, they being fastened to the planks at intervals of about 20 ft. The ways were laid level transversely, and no side shores were used except to correct any side curvature that might be in the timber. Cross ties of 4 × 6-in. pine were fastened under the ways about 30 ft. apart, to insure them remaining the proper width until the weight of the vessel came on them.

We have found in launching over mud that the vessel carries a wave of mud ahead of her, and it is better to fasten the ways directly to the planking, so that they will



VIEW NEAR BOW AT HEAD OF SLIDING WAYS.



VIEW NEAR STERN AT FOOT OF SLIDING WAYS.

BATTLESHIP HULL READY FOR LAUNCHING.

*Abstract of a paper read at the eighth general meeting of the Society of Naval Architects and Marine Engineers, at New York city, Nov. 15 and 16, 1900.

†Union Iron Works, San Francisco, Cal.

be the proper width when down to their proper level. If side shores are used and the ways rise up, the shores have a tendency pull the ways out (as their heels are usually lower than the ways) and the vessel drops between. The writer has seen several instances where this has happened, especially when the ways were canted in, however slightly. At the extreme lower end there was 7 ft. 5 ins. of water on top of the ways when they were down straight. Under the bottom of the vessel at frame 34 the top of the ground way was 9¼ ins. clear, thus leaving the wedge ¾-in. thick in the point, allowing ½ for a board to prevent the paint from being scraped (Fig. 4). At the extreme end of the vessel wooden saddle pieces were fitted with iron straps 10 ins. wide, let in at the ends and well fastened (Figs. 5 and 6). There were seven of these at the fore end and five at the after end, the remainder aft being under the stern tube, which formed an abutment for their upper ends (Fig. 7). Into these the ends of the poppets were fitted and spiked. Poppets were all of 12 × 12-in. timber. Where the vessel was flat enough to dispense with these saddles, pieces of timber about 4 ft. long were fitted to the bottom of the vessel with pieces of angle iron let into them, hooked under the plate lap (Fig. 8). Under these pieces, and under the poppets, wedges were fitted directly on top of the sliding way, one to each frame, making 72 wedges to each side. Average weight to each wedge, 16½ tons.

No shoring inside the vessel was used. All the packing and wedges was fitted, using a small block the thickness of the sliding way, so that they were greased before being put in place. The grease was what is known as tallow stearine, which is ordinary beef tallow put in strong bags and subjected to a pressure of 70 lbs. per sq. in. for 48 hrs. at a temperature of 70° F. This is heated and put on as nearly uniform as possible a scant 1-16-in. in thickness, great care being taken to have a smooth surface, so that the weight of the vessel will bear evenly on it, and not break it. Over this is put a layer of oil soap. No care is taken with the soap as the surplus squeezes out and does no harm. A range of temperature from 40° to 80° F. has little effect on this material.

The sliding ways being put in their butts are bolted together, and the dog shores are put in place, which are secured as follows: A cleat about 6 ft. long, 6 × 8-in. Oregon pine, is secured to the ground way, and a similar cleat to the sliding way, leaving a space of 5 ft. 6 ins. between for the dog shores, which are also Oregon pine, 6 × 8 ins. The end abutting the cleat on the sliding way is square. The end abutting the cleat on the ground way is at an angle of one in five, both ends being shod with iron. The end abutting the ground way is greased. This is held in place by a shore of Oregon pine, 4 × 6 ins., long enough to reach the ground. Under the dog shores a weight of 250 lbs. is suspended (Fig. 9), which is held up by a small trip hook pivoted at the under side of the ground way, the upper ends of which are held by two small wire ropes, which lead up to the launching platform. These two wire ropes are joined together with a piece of white sash cord led over a small lignum-vitæ block, secured on a table on the launching platform (Fig. 10). Over this rope is a guillotine (Fig. 11), which when released cuts the rope, both weights drop instantly, and knock out the small shores from under the dog shores; they being at an angle of one in five, fly out, and the vessel starts. The christening bottle is hung from the bow of the vessel with a ribbon, and held at the lower end by a slip hook, controlled by a magnet, which is released like the guillotine, by pressing a button, the button being fitted neatly in the table.

The launching weight of cruiser was 2,400 tons; moving part of cradle 34 tons (estimated), making a total of 2,434 tons. The ways had an effective bearing surface of 17⅝ ins. (there being ⅛ space between ribband and ground way, and ⅛-in. chamfer) by 274 ft. in length, making 793½ sq. ft. ÷ 2,434 = 3.064 tons per sq. ft. The cost of labor and material for the launch was $1,618, which equals 66 28-100 cts. per ton weight.

On the day of the launch there were employed 30 carpenters, 8 boys, 10 laborers, 8 riggers, superintendent of the yard, and yard foreman. The assignment of duties on the day of the launch was as follows: Superintendent in charge on starboard side. Yard foreman on port side. The men were equally divided on each side, and were all at the rams; eight men using each ram, and the remainder ready to change off. One ram was used on each side of the vessel.

The time occupied in the various operations of launching was actual working time, 76½ mins., resting time 52 mins. No speed data were taken, as we had made some careful experiments some months previous on a merchant vessel, which gave a maximum speed of 10½ knots per hour.

LAUNCHING OF BATTLESHIP.

The keel of the battleship was laid at an angle of 1 in 20, with the heel of the stern-post touching the water at high tide. As the mud outside of the yard was too high to admit of planking on top of it, we determined to use piles to the extreme end, and to reduce the cost it was determined to lay the ways on a curve. The curvature decided upon was 8 ins. rise of arc in 264 ft., which gave a mean inclination of ways in the length of the cradle before the vessel started to move of 1 in 21½, and at the extreme lower end 88 ft. from the heel, an inclination of 1 in 14 (Fig. 12).

When the vessel was laid down the keel blocks were 5-ft. centers. About three months before launching 28 additional blocks were put in, making 94 in all. There were seven bilge blocks and 61 shores on each side, making 230 blocks and shores, or about 17¾ tons to each block and shore.

The launch ways were the same as used on the cruiser for the inner half, and a new set of 10 × 18-in. for the ground, and 8 × 18-in. for the sliding ways placed outside of them, with a space of 10 ins. between. This arrangement spread the weight a little on the bottom, and enabled the dog shores to lay hold on both ways without bolting them together their entire length. The outer piece had no ribband, the only connection between them being one ¾-in. bolt at each butt, passing through a distance piece 8 × 8 × 10 ins. (Fig. 13), for the fastening at dog shores (Figs. 13 and 14).

The butts of the ground ways were in the center of the adjoining piece. The butts of the sliding ways were exactly opposite each other, the upper three pieces being fastened with plates well bolted. The lower two butts were fastened with wire rope; the ways were laid exactly level transversely and parallel their entire length with ½-in. ribband clearance at each side. No side shores were used except to correct any curvature in the timbers. At the lower end they were well tied together and sunk onto the caps without fastenings. The piles were cut off under water with a cross-cut saw from false work erected about 9 ft. above and parallel to the line of ways. The caps were bolted to the piles as far as could be at low water, and the remaining caps were fastened to the under side of the ways and sunk with them. As straight pieces were selected for the outer end, no difficulty was experienced in getting a straight line. The top of the sliding way was 3 ins. from the bottom of the vessel at the nearest place, which was nearly amidships.

The poppets and wedges were similar to those used on the cruiser, and spaced similarly, being one to each frame; making in all 73 wedges on each side, and an average of 28½ tons to each wedge. At the fore end where the strain of pivoting took place, the saddle timbers were made extra long and heavy, to spread the strain over the vessel, and under them small pieces of timber for crushing (Figs. 16 and 17), were fitted to spread the strain of pivoting lengthwise on the vessel and ways. They were of a uniform thickness of 6 ins.; the forward piece 6 × 4 ins.; next 6 × 5 ins., and so on, increasing one inch in width up to 12 ins., which was the width of all the packing and wedges. No inside shoring was used in any part of the vessel. On examination of the crushing pieces after the launch, we found the forward pieces less than 1 in. in thickness, showing that they made an excellent cushion.

The dog shores were of oak, 8 × 9 ins. × 5 ft. long, fitted between the ways in the 10-in. space already mentioned (Figs. 13 and 14). The small rope from the trip hook was led to the platform at the bow of the vessel, over a small post in the center of a table (Figs. 10 and 11). A small guillotine was used, which was controlled, as was the christening bottle, by an electric button. These buttons were fitted in neat boards, and presented as souvenirs to the young ladies that pressed them. The launch was a complete success, the vessel starting instantly when released, and moving rapidly to the water. As in the cruiser every piece of packing came out from under the vessel. A 6-in. Manila hawser was made fast to each sliding way at the fore end. Turns were taken around a post to come taut when the sliding ways dropped clear of the ground ways. All of the poppets, saddle pieces, packing wedges, etc., were fastened to the sliding ways with wire and Manila rope, and everything came out, they remaining at rest, and the vessel moving off them.

The launching weight of the vessel was 4,100 tons; cradle 62 tons (estimated); total, 4,162 tons. The bearing surface was 276 ft. long, two pieces 17⅝ and two 17¾ ins. wide; total, 1,621 sq. ft., 2.57 tons per sq. ft. The vessel was launched sooner than was expected, as the weight the ways were designed for was 4,800 tons, giving 3 tons per foot, which we consider the proper weight, and would have made the cost per ton less.

The cost of labor and material, including seats, decorations, cutting off and capping piles under water, etc., was $4,795. The assignment of duties on the day of the launch was similar to the other. The launching time was: Actual working time, 118 mins.; resting time, 37 mins.; total, 155 mins. The following table gives in condensed form the various dimensions and other data of interest in connection with the launches just described:

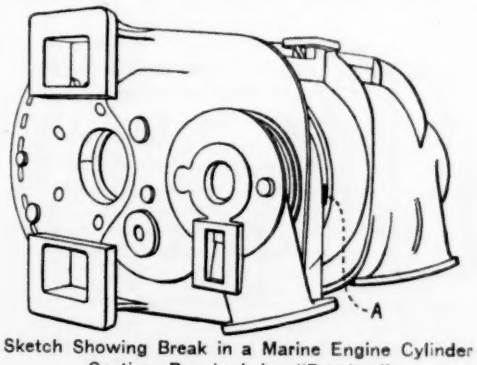
	Cruiser.	Battleship.
Length, ft.	344	348
Beam, ft.	52	69.3
Length of ground ways, total ft.	396	383
Length from stern-post to extreme end of ways, ft.	101	88
Thickness of ground ways, ins.	10	10
Length of sliding ways, ft.	274	276
Width, sliding ways, actual ins.	18	36
Width, sliding ways, effective, ins	17⅝	35⅜
Thickness of sliding ways, ins.	8	8
Area, slid'g ways, eff'tive, sq. ft.	793½	1,621¼
Spread, ground ways, c. to c., ft.	13½	25.1
Inclination of keel	1 in 20	1 in 20
Inclination of ground ways	1 in 18	1 in 21½ to 1 in 14
Camber	0	8 ins. in 264 ft.
Inclination transversely	Level	Level
Depth of water on end of ways	7 ft. 5 ins.	8 ft. 5 ins.
Distance, stern-post to water, ins	14	1
Launching weight, hull and machinery fitted on board, tons	2,400	4,100
Launching weight moving part of cradle, tons	34	62
Total weight, tons	2,434	4,162
Pressure on ways, per sq. ft, tons	3.064	2.57
Draft of water forward	6 ft. 6¾ ins.	11 ft. 2 ins.
Draft of water aft	15 ft. 5½ ins.	12 ft. 4¾ ins.
Tallow stearine used, lbs.	490	930
Soft soap, lbs.	585	1,000
Cost of labor	$1,174.00	$3,541.70
Cost of material	$435.10	$1,253.00
Cost of labor and material	$1,610.00	$4,794.70
Cost per ton, labor only, cts.	48¼	85
Cost per ton, labor and material	66¼	1.15
No. men employed l'nching day	58	88
Cost of launch day	$153.50	$245.95

THE "BURNING" OR MENDING OF CASTINGS.*

By Edward B. Gilmore.†

It has often been questioned whether it was advisable to burn castings which are broken or have proved defective, even after a great deal of expense had been put upon them, and when one begins to theorize upon the matter, the natural conclusion is that it is impossible to mend a casting by burning. When we get to practice, however, we find that the reverse is the case, and I have burned castings which were considered by many founders to be hopeless. For instance, in making a marine cylinder, a piece was broken from a sharp point of the exhaust core which the coremakers had not secured fast enough, and this caused a hole to be left clear through to the outside of the casting, as is shown by A in the accompanying cut.

The procedure that we adopted was based upon the laws which govern expansion and contraction as nearly as possible. We put the casting upon a car with the defective side uppermost, and made loam molds to cover



Sketch Showing Break in a Marine Engine Cylinder Casting Repaired by "Burning."

this, also a loam mold to fit the inside of the casting at the same place. Then we took back the molds, dressed them up and gave them a coat of blacking, dried them thoroughly, put them back to their places, and secured them tightly to the casting. We then made a runner to take off the metal poured upon the casting, the overflow of which was caught in another ladle placed for the purpose. After all the arrangements had been completed the whole thing was put into the oven, which is a very important matter, as you must get the casting as well warmed as possible, for this is where the success or failure in burning comes in.

It is essential to have a casting to be treated in this way heated up to at least 600° F., and this can easily be accomplished. After an oven is thoroughly heated with the usual coke fire, about 1½ hours before you have the metal ready for burning, fill the fire in the oven with soft wood, and continue doing so until ready. This will raise the temperature to the desired point. In order to assure yourself that the oven is hot enough you can put a piece of lead upon the car; if it melts you may be certain that you have the temperature high enough—lead melting at 612° F. You could also place a piece of tin on the car, as it melts at 442° F., and by doing so you will be able to determine very nearly to what temperature your oven has been heated. When everything was ready in the case under discussion the car was pulled out of the oven. The metal, good and hot, was poured into the mold prepared upon the casting, enough being used to melt the casting about 1 in. on either side of the defective part. Dry charcoal blacking was used to cover the cast, and then the whole thing was run back into the oven and let cool gradually.

I have burned a number of large castings on this principle, and have been successful in every instance. The iron used for this purpose should be of the very softest nature, so as to keep down the shrinkage, and make it easy for machining and chipping.

There are many castings which can be easily burned without being brought up to this excessive heat, such

*Abstract of a paper read before the American Foundrymens' Association.

†Milwaukee, Wis

as when you have to mend on some extreme point, where undue expansion and contraction will not matter. We once had occasion to burn the casing of a centrifugal pump which got broken right across the casting. This was burned very successfully without preliminary heating, but even in this case it would have been advisable to heat the casting, as it would have facilitated the running of the metal. I have seen castings of this description burned cold, and as soon as the metal touched the cold iron it was chilled, and the consequence was a failure. The result was that the pieces were thrown away, and this only on account of an insufficient knowledge of the best methods in the art of burning and mending of castings.

Some founders in burning castings make a practice of bringing the metal forward in small ladles, with the idea of bringing it very hot in this way. This is a mistake, as you can put it all into one ladle and by having a large quantity it will hold its high temperature for a longer period. When you pour you can maintain a good, steady stream upon the part, besides reducing the extra expense of additional help in handling so many ladles.

In burning the neck on rolls, it is much better to adopt the principle of making a loam mold, leaving a hole at the bottom so as to run off the metal until the roll is melted. After the mold is prepared, finish and dry it, then secure it to the casting and build a good hot fire around the casting at the part to be repaired until it is a bright red. Now pour very hot iron into the mold and allow it to flow off until the casting is melted. This can easily be determined by trying it with a feeling rod, and when satisfied stop the exit of the metal and fill the mold to the required height. You can also burn a steel face on to a hammer die on the same principle, but it is not necessary to heat the steel as the iron melts it very rapidly.

The question is very often asked, "Is the casting as strong after being burned as it was previous to being broken?" In a great many instances it is stronger, as very often there is a contraction strain upon the casting which has been relieved by the breaking, and when properly mended it should be certainly as strong.

CIVIL SERVICE EXAMINATION QUESTIONS FOR STRUCTURAL IRON DESIGNERS.

The Civil Service Commission of the City of Chicago, on Oct. 26, held an examination of candidates for the position of structural iron designer. We are indebted to Mr. T. J. Corcoran, Secretary of the Commission, for a list of the questions used in the examination. These we reprint below, as they will undoubtedly interest many of our readers:

STRUCTURAL IRON DESIGNERS' EXAMINATION.

EXPERIENCE.—State what experience you have had to qualify you for the position of structural iron designer. Give dates, names of employers, and length of service.

(1) Fig. 1 shows the stress sheet of a 130-ft. span; what will be the approximate weight of metal? Indicate method used for obtaining result.

(2) Calculate size of pin necessary for the connection shown in Fig. 2, assuming that 20,000 lbs. per sq. in. are allowed in bending and 15,000 lbs. per sq. in. in shear. Give details of calculation. Graphical method may be used.

(3) A span of 80 ft. is required to carry street traffic. No limit is placed for the depth of the structure. Distance between centers of main girders is 24 ft. The pavement is to be cedar block laid on 4-in. planking, the latter resting directly on the steel floor. Assuming a moving load of 100 lbs. per sq. ft., design the most economical floor using steel floor beams and steel stringers and straining them not more than 12,000 lbs. per sq. in. in the extreme fiber. Pencil sketches only will be required showing outline, sizes and dimensions. State weight of steel floor per lineal foot of bridge. Give also the sectional material for the main girders.

(4) An inclined end post, shown in Fig. 3, carries a total stress of 440,000 lbs. The web is ⅝-in. thick and there is only room for one ½-in. pin plate or hinge plate on the inside of each web. Assuming 18,000 lbs. per sq. in. to be the permissible limit for bearing on pins, 7,500 lbs. per sq. in. to be the limit for shear of rivets and 15,000 lbs. per sq. in. to be the limit for bearing on rivets, calculate the size and number of pin plates, the number of ⅞-in. rivets required, and show their arrangement for a 6½-in. pin.

(5) Do you consider a stiff or an adjustable lateral system as preferable for bridges? State your reasons.

(6) A column fixed at the base is to carry a fixed load of 100 tons applied centrally and ten tons applied eccentrically, 2 ft. from the center at top. Height of column, 40 ft. May be built of channels, Z-bars or plates and angles. Calculate column by any standard formula and give sketch of section with sizes and dimensions; also details of calculation and reasons for adopting the form of section.

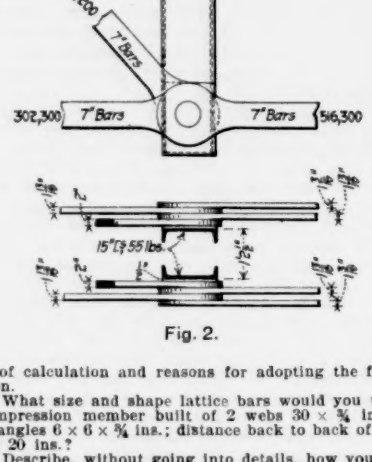


Fig. 2.

(7) What size and shape lattice bars would you use for a compression member built of 2 webs 30 × ¾ ins. and four angles 6 × 6 × ¾ ins.; distance back to back of angles being 20 ins.?

(8) Describe, without going into details, how you would design the following structure: A 200-ft. highway span over railway track with viaduct approaches, as shown in Fig. 4. Bed rock, 6 ft. below surface of ground. The headroom over tracks to be 20 ft. under 200-ft. span. Top of floor to base of rail not to exceed 23 ft. No limitation as to headroom under approaches. Roadway to be 40 ft. wide in the clear between curbs, with two 6-ft. sidewalks. Indicate in writing the principal characteristics of each portion of the structure, such as length of spans, columns, girders, floor, bracing, etc., assuming that the highest class of structure is required.

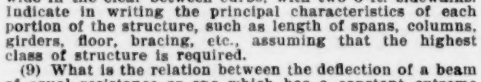
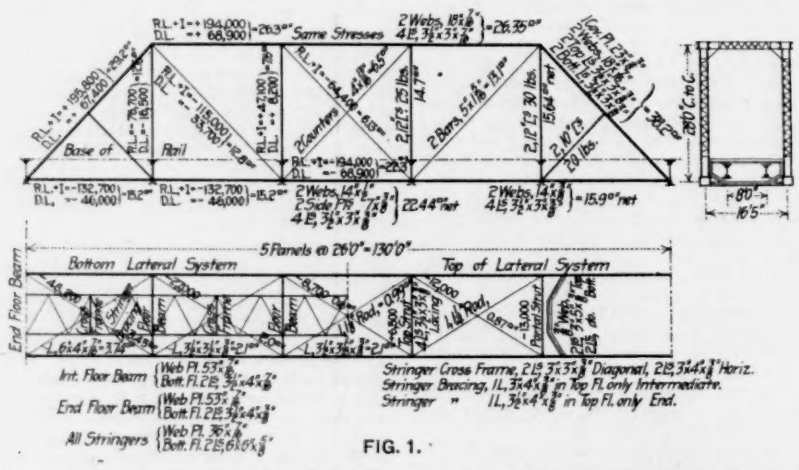


Fig. 4.

(9) What is the relation between the deflection of a beam of equal resistance or one which has a constant extreme fiber strain throughout its length and the deflection of a beam of constant moment of inertia, all other conditions being equal?

(10) Being given a continuous beam of 3 equidistant supports uniformly loaded, what is the end reaction expressed in terms of the total load?

The applicants may use a Carnegie "Pocket Companion" for reference in answering the above questions.


Base of
Panels
5 Panels @ 26'0" = 130'0"
Bottom Lateral System
Top of Lateral System
End Floor Beam
Int. Floor Beam
End Floor Beam
All Stringers
Stringer Cross Frame, 2 Ls 3½x3½x⅜ Diagonal, 2 Bs 3½x4⅜ Horiz.
Stringer Bracing, 1 L 3½x4⅜ in Top Fl. only Intermediate.
Stringer " 1 L 3½x4⅜ in Top Fl. only End.
FIG. 1.

THE POSSIBILITY OF AMERICAN COMPETITION WITH FOREIGN SHIPBUILDERS IN BUILDING LARGE OCEAN VESSELS.*

By Geo. W. Dickie.†

I am presenting this paper to the Society in response to a request received from the Secretary before starting out on a trip to Great Britain and Europe, the object of which was partly to note what advantages the shipbuilders there had over ourselves, either in skill, labor or material, that would enable them to produce great ocean freight and passenger carriers at less cost, or with greater certainty as to results, than ourselves. This paper is being written on board one of the latest examples of the shipbuilder's are in that combination of great cargo capacity and a moderate amount of very comfortable passenger accommodation, combined with a speed that was considered fast not so many years ago. The "Saxonia," on which I am writing this paper, is the embodiment, I think, of a higher type of skill in naval architecture than those vessels wherein everything is made subordinate to the one sought for quality of speed.

This type of ship will, I believe, become the most important in the future extension of American shipping. Here is a vessel that carries 9,000 tons of freight at 15½ knots on a coal consumption of 145 tons per day, or 1,280 tons of fuel used to carry 9,000 tons of cargo across the Atlantic, and at a speed that secures a large passenger patronage. Now the secret of obtaining this result is, first, the great increase in the size of ship, and, second, fitting engines of just the size required for the speed. The old idea of having a large surplus of engine and boiler power that the owner can never afford to run at its full capacity is a thing of the past, and ships are now designed with just sufficient power to meet the conditions as required by the trade in which they are to engage. Increased efficiency of engines and boilers has also helped in this astonishing result.

The question that forms the subject of this paper is one that has ever been present to my mind while visiting

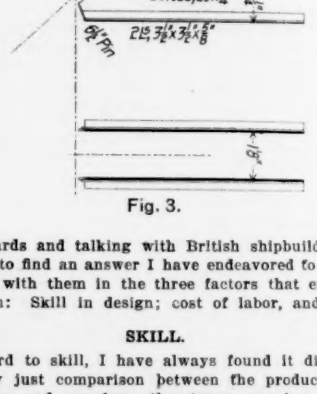


Fig. 3.

British yards and talking with British shipbuilders, and in trying to find an answer I have endeavored to compare ourselves with them in the three factors that enter into production: Skill in design; cost of labor, and cost of material.

SKILL.

In regard to skill, I have always found it difficult to make any just comparison between the product of one shipbuilder and another, the term meaning different things to different people. Skill in design must in merchant work have the commercial element as a prominent factor, and must embrace both the financial interests of the shipbuilder and the shipowner, and (in order to prevent these interests from injuriously affecting the interests of the shipper who entrusts his property on the vessel), the interests of the underwriter who insures the interests of the shipowner and merchant. Certain societies representing all the interests involved hedge the designer about with rules that give him but a very narrow field in which to exercise his skill as a naval architect. Yet, narrow as this field is, the progressive shipbuilders of Europe are continually pushing out the barriers, and forcing the recognition, by the registration societies, of new methods in construction, new properties that experience has shown to be desirable, and new combinations that have transformed, within the past few years, not only the dimensions of the ships built, but the whole method of construction. So that, hampered on every side as the naval architect is, by rules and traditions, his skill has been ever on the alert for the smallest opportunity to push out still farther the barriers set up against him.

In thus stating the obstacles that oppose the exercise of the naval architect's skill in design, I do not set these obstacles down as opposed to progress, but as limitations to the free exercise of the skill in design that many naval architects, and especially those of America, think they possess. When the ambitious young naval architect studies the rules, say of Lloyd's Register of British and Foreign Shipping, his first impression is that those people who make and maintain these rules are opposed to all progress, and imagine that they and the rules they have made represent the consummation of all that is possible in shipbuilding. As he gains experience, however, in his work, this first impression of his will be modified.

I have lately had to discuss with the chief surveyors at Lloyd's certain departures, that we considered slight and in the line of improvement, from the rules as applied to two large freight twin-screw steamers, which we are now building. I have found that the skill of the experts at Lloyd's, and the careful study of every proposition made to them, not only protects all parties, but insures a steady forward movement, consistent with the proper protection of all the interests involved. I believe, however, that an American register of shipping, that would be accepted by the shipowner and by underwriters the world

*A paper read at the eighth general meeting of the Society of Naval Architects and Marine Engineers in New York City, Nov. 15 and 16, 1900.

†Manager Union Iron Works, San Francisco, Cal.

over, would be a great help to the American shipbuilder, as it would no doubt lend itself more readily to the tendencies of American design. The British ship is the result of British experience, gained by British shipowners and sailors, embodied in British designs by the British naval architect, finally taking form in British shipyards; the result carrying with it much of the traditions and practice of the people and place where the work is done.

Now can we in America do better than this? We are very likely to do a little different, as much different probably as the limitations referred to will allow, and these differences will, I think, take the form of a closer adaptation of the material used to its place and function in the complete design. In this the steel manufacturer will likely take a share. As he becomes better acquainted with the special needs of ship construction, we will find him ready to undertake new sections better adapted to take the strains and stresses of ship structure, and reducing built up work to a minimum. We are on this point now abreast of the British builder, and, in methods of handling, ahead of most of them. In skill I think the American naval architect is quite abreast of his British cousin, and if he has plenty of practice there need be no fear of him keeping in that position. In some of the great shipyards of Britain and Europe they have acquired a greater experience in the production of the largest ocean steamships, both for passengers and freight, than we have: but we are in the way of obtaining this experience, and it will come to us just as it came to them, by a steady and skillful application of what we now have.

I find, also, especially among the younger naval architects in Britain, an opinion they are ready enough to express, that the United States is to be in the near future a rich field for the practice of their profession. I have found this opinion naturally strongest among those who feel the limiting power of British shipbuilding traditions strongest. Such men, if they come to our side, will have an effect in molding what may become American traditions in the future history of the art.

LABOR.

Granting, therefore, that there is nothing lacking in skill on the part of our designers, how are we in regard to the second factor in the problem of competition—that of the cost of labor? This is the one factor that presents the greatest difficulty in dealing with the problem of relative cost as between the shipyards of Great Britain and those of America. We work under different conditions in regard to a large portion of the work. The whole steel work of a ship may be said to be done under the piece-work system in Britain, the price per unit being fixed for certain shipbuilding districts between the shipbuilders and the unions representing the men. This method has its advantages, as it simplifies the estimating a certain known portion of the work having a certain fixed value. While a considerable portion of the work with us is done on some piece-work system, every yard appears to have its own way of fixing prices with the men. In the British yards, as with us, while practically all the steel work is done under some kind of piece system, yet on inquiry it appears that it is with them very much as it is with us; the number of men on wages on the very work supposed to be done by piece is greater than that of the piece-workers, and skill in management is directed to the reduction of the number of men on wages as compared to the number on piece work.

From combining what information I have been able to gather, I find that on an average the steel workers of construction cost in the British yards from £3 17s. to £4 per ton of material worked. This I think we can about equal in labor cost here. But when it comes to fitting out, including carpenter and joiner work, painting, and general finish, where piece work does not cut any figure, the cost, I think, is directly as the wages paid. We employ the same class of men as they do; in fact, our best men come from the British yards, and while in some of our yards we may have some advantages in climate, this does not apply to all, and where we are paying 50% more wages, the cost of labor that is reckoned in wages will be 50% more here than it is in a British yard. And if half the labor cost for any given ship built in a British yard is paid in wages—and this is very nearly correct—and that half costs 50% less than the corresponding part in our yards, our total labor cost will be 25% greater than theirs. This is very nearly correct, as tested by comparisons I have been able to make of actual costs as between our yard and one or two in Britain, where I have been furnished with labor costs. I am convinced, however, that although we pay higher wages to our office staff of draftsmen, that part of the work does not cost any more than in the British yards, as we seem to be able to do a like quantity of work with a smaller force. The managing staff in our yards are, I think, paid less than corresponding officers in the large yards there, and they devote much more time to their duties.

As to what we may be able to do in regard to equalizing the cost of labor as between our yards and those of Great Britain, I do not think that it will be brought about by any attempt to equalize the rate of wages paid throughout the shipbuilding world, but I have hopes that some of our rising shipbuilders among the younger members of our profession may be able to devise some method whereby every part of a ship, both hull and machinery, will have a labor value fixed for it that will not exceed what such a piece of labor costs elsewhere, and that whoever, by his labor, contributes to the production of that piece shall receive as recompense his portion, that is, the percentage that his labor represents in the total labor required to complete the part on which he worked. Something of this kind must be the foundation on which any true settlement of labor values must rest, and as it is done now with eminently satisfactory results in some of the most prosperous machine manufacturing establishments in England, it only needs the right kind of skill, honestly applied, to make it work in shipbuilding and engineering establishments in this country. I am so impressed with this, to me the only just way of recompensing labor, that were I 20 years younger I should take it up as a life work.

I find that the marine engine and its boilers cost less abroad in proportion to the hulls than they do with us. This is no doubt due to the fact that neither there nor here does piece work prevail in the production of the marine engine or its boilers, while machinists and boilermakers receive at least 50% more wages with us. In small tools I think we are better equipped than the engine works attached to the large shipyards there, but in heavy tools we are not better off than they are.

Some prominent engine builders in this country seem to be able to compete with engine builders in Great Britain, sending their engines to the very centers of engine building in that country, and, so far as we know, with profit to themselves. At least they continue doing it, which would indicate that it is profitable. If this can be done with land engines it can also be done with marine engines, but not on present methods. We must be content without the professional luxury of introducing some engineering novelty with every ship we engine. I do not say that we should be satisfied without making substantial progress in marine engineering, but healthy progress is not inconsistent with a standard system of working that would greatly reduce the labor cost of producing a modern marine engine.

In a large and prosperous engine works that I visited in England, building a special type of engine, but in all sizes from 10 to 3,000 HP., I found that the term erection was not used. Every part of their engines is made to gage, and when finished from the tools is sent to an expert examiner at a large surface table, with accurate measuring instruments, whose business it is to determine if every operation performed by the tools on that piece has been accurately done; that every hole has been bored properly; that every face is in its proper plane. He signs the workman's card that did the work if it has been done correctly; if not, the work is returned to him for correction, or rejected if it cannot be corrected. Every piece of work has a fixed labor value. Every man gets his regular wages. If the work he produces exceeds in labor value the wages, he is credited with 50% of the difference. If the labor value of his work is continually less than the wages paid him he cannot continue to work in that establishment. The pieces thus produced that go to make an engine when brought together are not erected as we do, fitting each piece to its place by file or chisel, as may be, owing to defective tooling; but they are placed in stock ready to be assembled in a few hours on receipt of an order for an engine of the size they represent. A system to insure correct tooling on every piece entering into the construction of our marine engines would, in my opinion, reduce the cost of erection by one-half. Some such system, and making every man a partner, so far as the result of his own labor is concerned, would place us in marine engineering where we are now in the production of land engines.

If we are to pursue the same methods as we are now doing, which are just the same as those that prevail in the shipbuilding and marine engineering centers of Great Britain and Europe, our labor costs will be very nearly in proportion to the wages of rates as compared with theirs. But in the development of some plan whereby we can fix a labor value for all our work that will not exceed theirs lies our salvation, and the American workman would, in my opinion, profit largely by the general adoption of some such plan.

On our present methods our labor cost is, as near as I can compute it, 25% greater on the hull and 50% greater on the machinery of an average ocean going freight and passenger steamer. I trust this statement will be carefully discussed by any member of this Society who has any knowledge on this question of labor costs, for much of our future progress in shipbuilding depends upon how we are able to solve it.

MATERIAL.

The most important material affecting the cost of shipbuilding is steel, and the tremendous fluctuations that at times take place in the price of that material in this country, is the most serious question we have to contend with in trying to predict anything in regard to the future of shipbuilding in this country. The tariff on steel plates and shapes makes it possible for us to find the British shipbuilder working into his ships American steel from Pittsburg at a less cost to him than the English material, and at less cost than is charged the American shipbuilder for the same material in Pittsburg. I saw in a yard on the east coast of Scotland steel being worked into a vessel that was delivered in the yard from Pittsburg at less than £7 2s. 6d. per long ton. If the American steel manufacturer can meet the British steel manufacturer on equal terms in the British shipyards, somehow it seems as if it might be possible for the American shipbuilder to get his steel material as cheap as the British shipbuilder gets his. This is all that I can possibly advance on this part of my subject. As the duty on steel of this character is not a protective measure, and cannot possibly produce revenue, it should not be maintained to render wild fluctuations in price possible.

I may be wrong, however, as to the cause of the immense variations in the price of steel here, but I think I am right in saying that such conditions relative to the most important material he uses are a great obstacle to the progress of the shipbuilder in this country. Engine and other forgings cost more with us than they do in Britain and Europe. In ordinary forgings of steel this difference is from 30 to 50%, and in high grade forgings, such as are required by our Navy Department specifications, there is no comparison. The usual extra charge for nickel steel forgings in Britain is £4 per ton extra for each 1% of nickel in the steel. I did not find nickel steel forgings being used at all in merchant work. On the whole, I think the British builder has an advantage over the American builder in the cost of material. This applies even to the wood used. As near as I can judge at the present time there is 10% in cost of material in favor of the British shipbuilder, as compared with the cost of material in American yards.

From the foregoing, if the statements I have made are correct, we are not yet in a position to compete with the shipbuilders of Britain or Europe (Europe meaning Germany only), the difference being not less than 15% on the finished ship. As we gain experience and adopt new methods, especially in regard to the management of that most important factor, labor, this difference may ultimately disappear. Some wise legislation will have to be devised that will enable the American shipowner to build his ships here, although costing somewhat more until we have found out the way to pay American labor to build American ships that will not cost more than the British ship built by British labor.

INTER-ISLAND TELEGRAPH CABLES for the Philippines are to be laid shortly by the cable ship "Burnside," under orders from the War Department. The "Burnside" was captured in the Spanish-American war and was converted into a troop-ship, but is now a cable-steamer fitted with three tanks each holding 250 miles of cable. The cable-laying will be in charge of Capt. Squires, of the U. S. Signal Corps, and about 625 miles of deep-sea and shore-end cable are now in the tanks of this ship. The laying of these cables will greatly facilitate American operations in the islands.

OCEAN SOUNDINGS OF OVER 5,000 FATHOMS were made by the surveying ship "Nero" in its investigations of the proposed cable line from the United States to the Philippines. Rear Admiral R. B. Bradford, Chief of the Bureau of Equipment, in his annual report, refers to these surveys as follows: Last year and this year Lt. Com. Hodges, in the "Nero," has been sounding along the lines suggested, with the following general results: From Honolulu to the Midway Islands, on a route to the northward of a line of reefs running about west-northwest from the Hawaiian Islands, he finds an almost level plain of soft mud at a general depth of about 2,700 fathoms. Between Midway Islands and Guam is another plain with depths of from 3,100 to 3,200 fathoms, with some submarine reefs and mountain ranges. In last year's report mention was made of an abyss found not far to the eastward of Guam; this Nero Deep, as it is now called, has been further investigated. In November, 1899, Lt. Com. Hodges made the two deepest ocean soundings and took the deepest temperatures ever recorded. The depths found were 5,100 and 5,269 fathoms—or nearly six miles; and the temperatures were 35.9° F. at 5,070 fathoms and 36° F. at 5,101 fathoms. He found a practicable cable route, however, to the north of this Deep, though its southern limits are yet unknown, and greater depths may yet be found. Between Guam and the Philippines the bed of the ocean is less regular, but the bottom is soft ooze and favorable for cable-laying. The route from Guam to Yokohama lies to the westward of the Ladrone Islands and eastward of the Bonin Islands. An almost level plain, with 2,100 fathoms, was found for 500 nautical miles from Guam. At that point a submarine mountain range appears which apparently connects the range extending from the coast of Japan to the Bonin Islands with that of the Ladrone Islands. In crossing this range a submarine peak was found reaching to within 83 fathoms of the surface. To the north of this range the ocean bed slopes gradually to the eastward into the great Japanese Deep, that for years held the record for deep water, until the English survey ship "Penguin" found greater depths in the South Pacific. The greatest difficulty to be overcome is in finding a suitable crossing of this range between the Ladrones and Bonin; with this done the remainder of the route is excellent for cable-laying.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Entered at the New York Post-Office as Second-Class Matter.
Published every Thursday
at St. Paul Building, 220 Broadway, New York, by
THE ENGINEERING NEWS PUBLISHING COMPANY

GEO. H. FROST, - - - - - - - - - PRESIDENT.
D. McN. STAUFFER, - - - - - - - VICE-PRESIDENT.
CHARLES WHITING BAKER, SECRETARY AND MANAGING EDITOR.
F. P. BURT, - - - TREASURER AND BUSINESS MANAGER.

WM. KENT, E. E. R. TRATMAN, M. N. BAKER, CHAS. S. HILL, } ASSOCIATE EDITORS.

A. B. GILBERT, - - - - - - - ASSISTANT MANAGER.

CHAS. W. REINHARDT, - - - - - CHIEF DRAFTSMAN.

ALFRED E. KORNFELD, New York,
M. C. ROBBINS, Chicago,
S. B. READ, Boston,
C. F. WALKER, Cleveland, } ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE, 220 BROADWAY, NEW YORK.
CHICAGO OFFICE, 1636 MONADNOCK BLOCK.
BOSTON OFFICE, 170 SUMMER ST.
CLEVELAND OFFICE, OSBORN BUILDING.

FOREIGN AGENTS.

C. MITCHELL & Co, Snow Hill, Holborn Viaduct, LONDON.
RUDOLF MOSSE, BERLIN and HAMBURG, GERMANY.
JOHN F. JONES, & CIE. 31 Rue de Faubourg Montmartre, PARIS.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 *months,* $2.50; 2 *months,* $1.00. *To all other countries in the Postal Union: Regular Edition, One Year,* $7.60 (31 *shillings*); *Thin Paper Edition, One Year,* $6.31 (26 *shillings*). *SINGLE COPIES of any number in current year,* 15 *cents.*

In requesting change of mailing address, state BOTH old and new address; notice of change should reach us by Tuesday to be effective for the issue of the current week. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 321 *means that subscription is paid to the* 32*d week (that is the issue of Aug.* 8) *of the year* 1901; *the change of these figures is the only receipt, unless one is sent by special request.*

ADVERTISING RATES: 20 *cents a line. "Want" and "For Sale" notices, special rates, see page XXI-XXIII. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.*

The rapid growth in favor of the steam motor vehicle during the past year, and the embarking of numerous firms in its manufacture, is a matter worthy of particular notice. When "automobilism" was first taken up in this country, the electric vehicle appeared to have the ascendancy. It was such an easy matter to load a storage battery into the body of a vehicle and gear an electric motor to the axle, that plenty of concerns were ready to supply the demand. The well-known defects of the storage battery, however, with the great expense of machines driven by them, were soon appreciated; while the fact that such vehicles can only operate within reach of a charging station also operated against them. We do not hear any longer the claim that the electric vehicle is to be the typical American motor-vehicle. From present appearances that distinction is much more likely to be awarded to machines propelled by steam.

One reason for the success of the steam vehicle, we believe, is that it has been taken up as a legitimate manufacturing industry and not as a scheme for selling stocks to a gullible public, whereas both electric vehicles and gasoline engine vehicles have been to a large extent boomed for stock market purposes solely.

On the other hand, it is true of the steam vehicles as of those propelled by other forms of motive power, that in many cases machines have been put on the market without sufficient consideration of the mechanical principles involved. It is one thing to hitch a steam engine to a carriage body in such a manner that the machine will go; but it is quite a different matter to make a machine that can stand up under daily service on all roads and all weathers, without undue cost for repairs and with reasonable freedom from disastrous breakdowns on the road. It is pretty safe to say that the steam motor-vehicle of ten years hence will be a very different machine from that of the present day.

To note only one change, which should be made, and that without delay, it is entirely clear that some other fuel than gasoline should be chosen to burn under the boiler. Of course, gasoline makes an admirable smokeless fuel, and produces a high degree of heat; but if the motor-vehicle industry is to develop at any such rate as the manufacturers prophesy, it is plain that the world's production of gasoline will not begin to supply the demand. The volatile distillates of petroleum constitute not more than 10% of the American petroleum product, and a much smaller proportion of the foreign petroleums. Their consumption in various arts is enormous, and is constantly increasing. That much higher prices will rule for them in the near future may be taken as certain.

Other advantages also favor the substitution of kerosene or crude oil in place of gasoline on steam motor vehicles. The danger inseparable from the storage and handling of gasoline, especially by artificial light, and the difficulty in obtaining it in many places would operate against the gasoline carriage and in favor of the steam-driven vehicle if the latter were to use kerosene instead of the more volatile product.

It is very likely true that some experimental work would have to be done to develop a satisfactory system of kerosene-burning for steam vehicles; but so far as we know there are no inseparable difficulties to prevent final success, and the change would do much to popularize the steam motor-vehicle.

In marked contrast to the meager and poorly classified accounts of many city departments, commented on in our issue of June 14, 1900, is the bookkeeping of the water-works of Springfield, Mass. The last report of the water commissioners of that city contains a very satisfactory summary of statistics, in accordance with the schedule suggested by the New England Water-Works Association, besides which additional financial details are given. Expenditures have been apportioned to construction and maintenance accounts and the receipts are also classified. The compilation of statistics for the years 1897-8-9, given in the Journal of the New England Water-Works Association for September, 1900, shows that nearly thirty water-works are now using the New England schedule, but it appears that it is not followed very closely, in many cases. It would be a great aid to water-works managers generally if all of them would keep their records as carefully as is done in Springfield, and if good summaries of these records were presented in the annual reports. Mr. A. R. Hathaway is registrar of the Springfield Water Department.

LETTING CONTRACTS WITHOUT COMPETITION.

The long-continued dead-lock between the Government and the armor-plate manufacturers has at length been settled by the closing of contracts for about 36,000 tons of armor at a total price of about $16,000,000, the contract being divided equally between the Carnegie and the Bethlehem companies, and the prices varying from about $400 to $452 per ton.

It is interesting, in the light of these figures, to recall the discussions in the last session of Congress over prices of armor-plate. The Naval appropriation bill as passed by the House allowed $545 per ton for the best quality Krupp process armor-plate. The Senate refused to allow so large an amount, however, and a compromise was finally effected by which the whole matter was left to the discretion of the Secretary of the Navy, authority being given him to proceed with the construction of a Government armor-making plant in case he was unable to obtain terms which he deemed "reasonable and equitable" from the armor-plate makers. It was doubtless this weapon in the Secretary's hands which finally induced the two armor-making concerns to lower their bid to the figures named above.

The situation in which the Government has been placed in these negotiations is one which occurs so frequently nowadays, and one in which such large responsibilities are laid upon the official representing the public, who is not seldom an engineer, that it seems to merit some discussion in these columns.

The root of the whole trouble, it may be said at once, is that we are attempting to rely on the principle of competition to regulate prices in a field where it is impotent and inadequate to do so. Our laws are based on the theory of free competition. The Government officials are compelled by law to publicly advertise for bids to supply armor-plate as if they were buying bacon or blankets, and as if a dozen or a hundred firms and individuals could step in with a bona fide bid. The evil in this practice is not the absurd red tape of advertising for bids, when it is known in advance that no really competitive bids can be obtained, but is the fact that the law relies on competition to protect the Government with respect to price, and leaves it without protection when competition disappears.

It is time that the real condition of affairs was frankly recognized by our law-makers; and that methods were adopted and sanctioned by law which will better protect the public interests.

The armor-plate matter well illustrates this: As we have already noted, the Secretary of the Navy was instructed to purchase armor provided he could obtain it "at a reasonable and equitable price." Is the figure which he finally accepted "reasonable and equitable," and how did he or how can any one, no matter what their expert qualifications, determine what constitutes "a reasonable and equitable price" in the absence of competition?

There are all sorts of curious answers to this question in these days. We even hear the doctrine defended that the man with a monopoly—or the corporation with a monopoly—has a perfect right to take advantage of it. According to this doctrine, the armor-plate makers had a right to make their price as high as the necessities of the Government would permit. By the same token, the steel rail pool has a right to set its prices as high as it deems the railways will pay rather than go without the rails; the street railway (barring franchise restrictions) has a right to charge its passengers as high a fare as they will pay in preference to walking or traveling by some other mode of conveyance. After all, however, the defenders of this doctrine are few and far between, and it can never be sustained in the courts. The armor-plate manufacturers had no legal or moral right to raise their price because it was necessary for the Government to have what they alone could furnish.

It may be of interest to see what argument was actually used by the armor-plate makers as justification for their original asking price. It was said that the Government had paid a certain price per ton for the last Harveyized armor furnished. The new Krupp armor was alleged to be more expensive to manufacture, and to involve a payment of $40 per ton (if we rightly recall the figures) by way of royalty. It was also alleged that the new armor was so much better than the old that a thinner belt would give equal protection, and hence that it would cost the Government no more to equip a given vessel with the new armor than the old. In view of these facts, the armor-plate makers, we believe, set their asking price about $100 above the old rate on the last contract.

But all this, again, is far from proving this price to be "reasonable and equitable." The old price was fixed by the same happy-go-lucky methods as the new. The Krupp armor may be more expensive to make than the Harveyized; but $60 per ton seems a rather generous allowance for this. The $40 per ton royalty for the Krupp process appears to have dwindled now to $24.32, and one wonders who has submitted to lose a "rake-off" of some $15.68 per ton on 25,000 tons which they would have received had the first offer of the armor-plate makers been accepted.

We will now attempt to define what constitutes a "reasonable and equitable" price—not only for armor-plate, but for any commodity whose price cannot be fixed by competition. Such a price

must be a sum which will repay the producer all his expenditure for labor and material, in whatever form it may have been bestowed, and which will in addition give him a reasonable return upon his invested capital, the risk involved in the enterprise being always considered. It may be objected, perhaps, that this definition does not include payment for the skill expended or for profits; but this is not the case. The skilled manager's compensation is rightly classed under the head of labor, and reasonable profit should be included in the return on the investment.

Perhaps the armor-plate prices just agreed upon are "reasonable and equitable," but the public will not be satisfied of it, because the basis on which its determination is possible has been ignored in fixing these prices. We do not say this to criticise Secretary Long's action. He has, we doubt not, made the best of a difficult situation. The trouble is with the system, not the men. It has been attempted to run a business in which free competition cannot exist upon a competitive basis and such an attempt is always disastrous.

The sensible way of dealing with the armor-plate business would have been to have recognized it as a natural monopoly at the outset. At that time, the Government might either have established its own armor-making plant, or, if it was deemed better to obtain the advantage of the organization and skill of one of the great steel-making concerns, a permanent contract should have been made, by which it would become the sole maker of armor-plate for the Government, the price being computed from the actual expenditure of labor and material plus an agreed allowance for interest on investment and profit—and the whole operation, including the bookkeeping, being subject, of course, to Governmental supervision.

The sooner we adopt some such common-sense method of dealing with the problems of monopoly and abandon the present short-sighted policy of trying to keep alive competition by sinking capital in the construction of new competing plants, the better it will be for the public.

As we have said, this question is far broader than the mere matter of prices of armor-plate. It is important, for example, in city administration. There are cities still, we believe, which go through the farce of opening annually bids for lighting streets with gas, or electricity, or furnishing telephone service for the current year. In the matter of garbage disposal, which is now receiving so much attention, it appears to be thought that the proper thing to do is to open the matter to public competition and invite bids for removing and treating in a sanitary manner the city wastes for a short term of years, three to five, perhaps. No one seems to remember that a permanent and substantial plant for effecting this is a first requisite for such work, and that the contractor, if he does business on a proper basis, must get back his investment within the term of his contract, and must fix his price accordingly.

We have another illustration of the impotence of competition in the case of engineering works of great magnitude. When the New York Rapid Transit Act was passed, those who framed it required the whole work to be let to one contractor. The result, as might have been expected, and as this journal indeed predicted, was that there was almost no competition, only two bids being received. When the work was divided into sections and sub-contracts were offered, a host of contractors were on hand with their proposals, and competition was most active. Boston, when it built its subway, divided the work into contract sections of moderate size, and was able to let them on most advantageous terms. New York might have pursued an equally sensible and economical course had those who framed the Rapid Transit law not been ruled by false theories of political economy.

Here is another illustration on even a larger scale: There has been at various times newspaper talk of contractors offering to build the whole Nicaragua Canal for the engineer's estimate, or for a sum considerably less. Probably when the enterprise is seriously taken up, as it almost certainly will be this winter, more will be heard of such offers. It hardly need be said that such propositions deserve to be and are likely to be promptly turned down. When that work is undertaken, it should, of course, be divided into sections and every contractor competent to bid should be given a chance to compete. To let the whole contract for one lump sum would certainly result in large loss to the Government.

We are aware that some critics will say that in all this we have not touched the root of the difficulty; that private enterprise is always to be preferred to Government work; and that public officials are so dishonest and incompetent that it is better to "farm out" Government work, even when competition is absent, rather than trust it to public officials. The answer to such criticisms is, first, that we do not think so meanly of the character of our public servants, and in the second place, that if these officials are really as bad as these critics claim, they have quite as many chances to line their pockets under the present system as they could were they given the direct conduct of the work.

The armor-plate matter is again an admirable illustration. If the Navy Department can be trusted to make the contracts for armor-plate which it has just signed, could not it be trusted to manage an armor-plate mill? If it can honestly protect the public interests in dealing with the armor-plate monopoly held by two concerns, could not its honesty have been trusted to carry out the other plan we have suggested and formally recognize the monopoly of a single firm? Will any one argue that the quality of the product would be worse in a Government plant, in view of the investigation a few years ago into the methods of doctoring blowholes in armor-plate?

Or let us take municipal administration again: If city officials are corrupt, was ever a better scheme devised to enable them to line their pockets than the plan of letting contracts to franchise companies for short periods? How nice to be able to comply with all the legal requirements, let publicly advertised contracts, win renown by much-heralded efforts to "foster competition," and pocket a nice perquisite which this very competition has stimulated into being!

These are some of the penalties which the taxpayers have to bear for the attempt to conduct natural monopolies upon competitive lines. Where a beneficial competition can be maintained, by all means let it be done; but where in the evolution of industry only a destructive competition, or none at all can be secured, it is for the public interest that the fact be recognized, and that other measures be provided for the protection of the public.

LETTERS TO THE EDITOR.

Multum in Parvo.

Sir: Noting in your columns the controversy over the setting of slope stakes, I beg to suggest that I have always found it so easy and simple that it is not worth serious discussion. As to modes of education, give your boy some kind of an education and if he has the "brains," energy and a fancy for engineering work he will succeed, —but don't forget the brains and energy.

B. T. Killough, C. E.

Carlsbad, New Mexico, Nov. 15, 1900.

Experiments on the Shrinkage of Earth in Embankments.

Sir: Relative to the discussion on the shrinkage of earth in embankments appearing in your issue of Nov. 15, the writer would report the result of two experiments: In 1872 a bank averaging 14 ft. high was built of pit gravel. The material was hauled onto the bank by and unloaded from wagons. The bank was finished to a level 14 ins. or 1 in. to the foot, whatever the fill was at the various stations, above the proposed grade. This bank settled to true grade in about six months, and at the end of a year had to be added to about 2 ins. This was a railway embankment. In July, 1882, a bank was built of clay, dumped from a train of cars alongside. Its height was 12 ft. The following October it was leveled off, and on Nov. 20 long stakes were driven in it at various points and levels taken. Testing from these on May 26, 1883, it was found that the settlement between November and May, the bank being entirely unloaded and supporting no traffic, that is the natural settlement only, was 7 ins. in 12 ft. Similar results have been found in other places, but in these the levels were actually taken with results above. This looks like a nearly direct contradiction of Mr. Gillette's statement in the above issue. I can only say they are facts, and not theories. Yours truly,

Chas. H. Tutton.

Foot of Main St., Buffalo, N. Y., Nov. -1, 1900.

Sir: In your issue of Nov. 15, 1900, Prof. J. B. Johnson has replied to my "challenge" to produce evidence that an earth embankment shrinks 16⅔% after construction, by citing Mr. P. J. Flynn's article on "Shrinkage of Earthwork," with which I was already familiar.

It is argued by Prof. Johnson that since Mr. Specht's experiments showed a swelling of 9.4% upon taking earth from cut and placing in fill, and since "sundry authorities," most prominent among whom, by the way, is Elwood Morris, have found that the ultimate shrinkage is 10% from cut to fill, embankments built with horses and scrapers will in course of years shrink 19.4%. This is a lame answer to my "challenge" to produce evidence, for the results of no one investigator quoted show any such shrinkage (16⅔%) of embankment after completion, and this Prof. Johnson practically concedes in reaching the conclusion that he does. He has presented deductions from evidence—not evidence.

Now as to facts. A dike of loam and gravel (15 ft. high) built under my direction on the Chemung River four years ago has shrunk 3 ins., yet it was never rolled.

Road embankments in Whatcom County, Washington, built under my supervision eight years ago have shrunk since completion only 2 ins. in 6 ft., yet they were never rolled and were of sandy loam placed with scrapers.

The high bank on the Erie Canal, built in 1850 between Pittsford and Bushnell's Basin, measured from original soil to bottom of canal 20 to 24 ft. high, has shrunk inappreciably. The depth of wafer according to my survey in 1897 is in no place over 0.7 ft. greater than in other places in the immediate vicinity where the canal passes through a cut, which would not be the case had any such shrinkage as 16⅔% taken place; for let us assume that in the 50 years since its completion the embankment 24 ft. high had shrunk ⅙, or 4 ft., then the tow path and berm would have had to be raised an equal amount, or overflow and destruction of the bank would have occurred; and we ought now to find the water 4 ft. deeper on the embankment than elsewhere, unless the bottom had been correspondingly filled. As a matter of fact no material has been placed in the bottom, according to canal records, and in borings made in the bottom I have found the original puddle practically uncovered by silt or other deposit. Moreover, the sides have always been sheet planked so that wash could not have silted the bottom anyway.

I referred in my last letter to a dike built in this state where a contractor lost money due to undue allowance made by the engineer for shrinkage. Two years after the completion of the contract, I found that in that dike, 16 ft. high, built with wagons, the vertical shrinkage has been 3% or about half a foot. A gravel embankment 12 ft. high built by the writer across the swampy inlet of Lake Otisco has shrunk in a year since completion about 4% and this includes some settlement into the soft bottom, but the shrinkage during construction was much greater; the material was not rolled and was delivered in cars on a track.

Instructions to engineers on certain railways provide for a shrinkage of 2 to 4% after completion. Mr. William F. Shunk says in his instructions for the South Penn. R. R. engineers, "Finish all earth embankments 4% of the record height above grade," and adds, "It is believed to be sufficient allowance for embankments made in layers with scrapers and approximately correct for heavy dumped work on good bottom which advancing more slowly must needs have gotten to its bearing in some measure before completition."

In Appendix G. of Gillespie's "Manual of Road Making," he says:

In making high embankments in the usual manner allowance must be made for settling and the banks be made so much higher originally. The following has been used:

For	banks	5	ft.	high,	3	ins.,	or 5%
"	"	10	"	"	5	"	" 4%
"	"	20	"	"	8½	"	" 3½%
"	"	28	"	"	10	"	" 3%
"	"	35	"	"	11	"	" 2¾%
"	"	40	"	"	12	"	" 2½%

It is undeniable that earth, being so variable in composition, will show great difference in the matter of swelling and shrinking, but I have confined my remarks to earth embankments built with wagons and scrapers, and since there is so great a discrepancy between 3% and 16⅔% either Prof. Johnson or I must be wrong, or by some freak of chance we have made all our observations upon earth widely differing in character.

Were it desirable I could give still more evidence from my own experience showing that 3% shrinkage after completion is seldom exceeded; but believing that there are surely other engineers whose experience agrees with mine and that they will be heard from, I shall say no more except to renew my "challenge" to Prof. Johnson to present facts based on actual observations and not based upon questionable deductions from the data of "Mr. Specht of California." Yours truly,

H. P. Gillette.

Rochester, N. Y., Nov. 17, 1900.

A Fly-Wheel Disaster and Its Lessons.

Sir: On Nov. 16 there occurred at one of the boiler manufacturing establishments of Detroit a fly-wheel accident which, although not serious from the standpoint of loss of life and property, nevertheless should convey a timely warning to a certain class of employers using steam power.

The engine in question was a comparatively new Nordberg Corliss running an air compresser and shop machinery at a speed of 90 revolutions per minute, although it was designed for 150. The fly-wheel was 9 ft. in diameter with a rim 1½ ins. thick and 19 ins. wide, not ribbed or otherwise reinforced between the arms. It was made in halves and bolted together at the hub and rim. The engine had been running satisfactorily for a period of six months. At the time of the accident, without a warning of any kind, the fly-wheel suddenly burst, completely wrecking the roof and opposite walls of the engine-room, together with everything outside in the path of the flying pieces. A 3-ft. length of the rim tore its way through a heavy timber roof girder, landing about 500 ft. away and burying itself completely in the earth. This apparently made a path for a second and smaller section of the rim which found an appropriate resting place in a heap of scrap iron a quarter of a mile away.

A boiler iron hood encasing the lower part of the fly-wheel was carried around the shaft and stowed away among the valve gear, while the governor escaped injury. There were several narrow escapes by employees, but no casualties.

As to the causes of the failure? Upon questioning the engineer I found that the valve gear had been in good working order, steam pressure normal and compressor load nearly constant. But where was the engineer when the accident happened? In the shop drilling holes in boiler shells. Why? Because he had been told that his services would not be required if he could not spend his leisure (?) time in the shop. He had protested, but to no purpose, his employer thinking that he need only spend a part of his time with the engine, which would run itself during the intervals of non-attendance. The engineer affirms with solemn conviction that the engine was running properly when he last visited the engine-room, 20 minutes before the accident.

To whose door can the blame then be laid, employer or engineer? Certainly not the latter, provided the engineer had given the engine all the care in his power. Let the engineer stay with his engine and give his whole time to it, for it will keep him busy if he gives it proper care. The immediate cause of the explosion was in all probability the fracturing of a small lever transmitting the impulses of the governor to the rods operating the cut-offs. When this was fractured the engine was left with open parts, and consequently its speed ran up in a few seconds beyond the danger limit. It is also possible that the cause of the rupture may be found in the loosening of the rim bolts, which, if the case, points to the necessity of drawing up these bolts when hot or of using some equivalent mechanical device for preventing the unscrewing of the nuts. Many steam users no doubt hold the proper opinion concerning the employment of their engine-room force and it is to be hoped that their influence will aid in discouraging the economical employer who endeavors to transfer a few dollars from his pay-roll to his profit account with such disastrous effect.

Yours truly, R. Biddle.

Detroit, Mich., Nov. 17, 1900.

Tracklaying on the Kersey R. R.

Sir: Having noticed in your issue of Nov. 8 an article entitled "Tracklaying on the Atchison, Topeka and Santa Fe. Ry.," I submit the following statement of tracklaying on the Kersey R. R., thinking perhaps that it might be of interest to some of your readers. The method employed was as follows:

The laborers employed on this work were nearly all stationed at St. Mary's and were taken out daily to the work, a distance of nine miles. The total length of track laid was 427 stations of 100 ft. each, so that ultimately the distance that the laborers had to be transported reached 17 miles. This transportation train also carried enough material for one day's work, which consisted of from two to three cars of rails, six to ten cars of ties and two flats loaded with spikes, bolts, tie plates, etc. The rail was in cars as loaded at the mill, which made it more difficult to handle than if it had been loaded on flats. Sixty-five per cent. of the ties came in box-cars, which limited the number of men that could be placed to unload them, and increased the liability of ties rolling down slopes on fills, as they were necessarily unloaded endwise from the cars.

The make-up of the train was as follows: One supply car, three cars of ties and three cars of rail placed alternately in the train; a tool car; the engine; four cars of ties and then another supply car. This make-up was at times varied according to the capacity of the cars. Most of the rail came loaded from 70 to 75 rails in a car; some cars, however, contained 100 rails and others but 50. Some tie cars contained 350 ties and others but 180.

The train would be taken to the end of the completed track and ten rails or a multiple of that number thrown off and enough ties to half-tie the amount of rail thus thrown off. The train would then be pulled back to clear and the iron trucks started. These trucks were of the usual heavy construction and were loaded in the following manner: Ten rails were loaded, base down, on the truck. Over these rails, separated from them, however, by two pieces of oak on the sides of the truck, were piled enough ties for this amount of rail. This truck was then run ahead to the tracklaying gang while the supply gang started to load a second truck in the same manner as the first. In the meantime, while the rail and ties were being loaded, spikes, bolts, etc., were being distributed from the supply car. These were loaded on a common push truck at the same time the rails were loaded and went ahead of the rail-car to the front.

Trucks passed one another by raising one truck to a vertical position on the cross ties and then allowing it to drop back to an oblique position, keeping it from turning over entirely by a prop. As soon as the loaded truck had passed, the empty one was allowed to drop back to its position on the track. A gang in the rear followed up, back-tieing, unloading ties from cars behind the engine. These cars were cut from the engine, the 2% grade being sufficient to allow cars to drop of their own accord, and so they did not interfere with the shifting of cars on the train ahead.

The men were divided into gangs as follows:

TRACKLAYING GANG PROPER.

Tracklaying foreman	1
Iron and tie truckmen	7
Jointing	4
Spikers	4
Holding up ties for spikers	2
Lining ties	1
Total	19

SUPPLY GANG.

Foreman	1
Unloading and loading rail and ties	12
Supplying joints, etc.	4
Picking up scattered material	1
Total	18

BACK-TIEING MEN.

Foreman	1
Spikers	4
Holding up for spikers	2
Lining ties	1
Unloading ties, spikes, etc.	4
Total	12

Grand total: 46 men and 3 foremen.

The men employed on this work were regular workmen of the Pittsburg, Shawmut and Northern R. R., but had been employed entirely on maintenance work before this time and some trouble was experienced in keeping them in their respective positions. The men of the supply gang claimed that their work was the most difficult.

The following statement shows material used and track laid:

MONTH OF SEPTEMBER, 1900.

Track laid	427 stations of 100 ft. each.
Average per day	2,870 ft.
Maximum	3,200 ft.
Rail	85-lb. Pa. Steel Co., Sec. 235.
Joints	Weber, 6-bolt joint, laid broken.
Ties	Swd. & hwd. oak, 18 to 30-ft. rail.
Tie plates	Q. & W. 3-16-in. plate, 3 spike holes laid on all curves.
Spikes	5 × ½ × 11-16-in.
Grade	2% descending.
Curvature	Maximum, 12° 30′; average, 5° 30′
Average number of men	45½ and 3 foremen.

This is exclusive of engineer, fireman, conductor and brakemen on work train.

On the last three miles of this road the ballast was broken ahead by another gang which made rather bad ground to work on.

Yours very truly, G. C. Woollard,
Engr. Maint. of Way, Pittsburg, Shawmut & Northern R. R. Co.

St. Mary's Pa., Nov. 19, 1900.

More Fun with the "Southern Review of Commerce."

The City Wastes Disposal Co., New York, N. Y.:

Gentlemen: We herewith enclose you an editorial which we have prepared on the subject of "Reliable Engineers," and we desire to publish it in the next issue of our paper. As your name is mentioned therein we ask that you make any corrections or changes that you think will strengthen the editorial and return us the manuscript as soon as possible.

As it might be of interest to you to distribute a number of these copies containing the editorial we will furnish them to you at the following prices: 15c. per copy; 100 at 12c.; 250 at 10c.; 500 at 9c.; 1,000 or more at 8c. per copy; an order for 100 entitling you to a year's subscription without further cost. We have on hand a list of parties we know to be interested in your line and if you so desire we will mail the copies to them and forward the list to you, making no extra charge for postage, marking, addressing, wrapping, etc. Whether you wish any copies or not please correct or O. K. the article and return as soon as possible. Awaiting your reply, we are,

Yours respectfully,
Southern Review of Commerce,
R. F. Starr, Editor.

Louisville, Ky., Nov. 15, 1900.

(The enclosure is the same old fairy tale which we printed in our issue of Nov. 8. Same "Bureau of Information," same "untiring efforts," same "ramifications of our data extending in every direction," same "conviction born of the acquisition of facts." By the way, what an easy subject for "conviction" this editor appears to be! Here is the reply which he received.—Ed.)

R. F. Starr, Esq., Editor Southern Review of Commerce, Louisville, Ky.:

Sir: I duly received your communication of Nov. 15, with its enclosure. My first inclination was to throw the whole thing into the waste basket unanswered, but, on second thought, I decided otherwise.

Of course I cannot permit the use of my name or that of the City Wastes Disposal Company in the way that you suggest. Any recommendation from your paper would, in my judgment, constitute just grounds for a libel suit. To compensate, however, for the loss of this eloquent and mendacious "editorial," and to fill space, I suggest that you print this letter. You are at liberty to use it without remuneration to the writer.

Moreover, I desire to reciprocate in kind your courteous attention, and to give your business enterprise the benefit of all the free advertising I can secure for you. With this view, I am sending your communication and a copy of this reply to the Engineering News. I fear that its editors will be unable to reproduce in full your literary effort, for they have already printed its exact prototype in the shape of a letter from you to Mr. John Doe, and I know that they have secured other samples of your skill and dishonesty; but I trust that they may show you the courtesy of brief editorial comment.

With a view to increasing the circulation of your paper (and the postage you pay for its distribution) I am bringing your publication to the attention of the post-office authorities at Washington. I am not entitled to any thanks for this, however. I am simply acting on a most excellent suggestion made by the Engineering News.

Yours truly, G. Everett Hill.

New York, Nov. 17, 1900.

Mathematical Work in Engineering Schools.

Sir: I have been interested and instructed by the articles on engineering education, which have been appearing in recent numbers of Engineering News. The letter of Mr. E. Sherman Gould, in your issue of Nov. 8, has been of particular interest, comparing, as it does, the results of instruction in the engineering schools with those of the schools for training in the other professions. Yet I am sorry to note the strong undercurrent of prejudice against mathematical studies, which is evinced in several of these articles.

It would seem that any criticism of the value of mathematical scholarship, since the profession is in great part based on mathematics, should make us inquire into the character of the instruction given in such studies before contemplating a reduction in their amount. The writer is free to admit that there are a number of the modern developments of mathematics, whose bearing upon engineering (or anything else of practical value) is so remote that time spent on them is, to a large extent, time thrown away. Yet it would seem that no technical education could be considered a complete one which stops short of a practical, working knowledge of the Differential and Integral Calculus. Anything less than this means the acceptance by the student of principles and results which can only be arrived at by clumsy processes with the lower branches of mathematics, or, in many cases, cannot be reached at all. A thorough and practical knowledge of the Calculus, besides its intrinsic value in mechanics, etc., is of inestimable value in adding to a clearer and deeper knowledge of all the lower branches. While it is true that young engineers may not be in a position for advancing scientific knowledge for many years, and, in most cases, never will be, yet it is also true that if all, or any of the engineering questions which now admit of only imperfect handling are ever cleared up, it will be by those engineers who have a thorough knowledge of mathematics, and its applications to physical science. If we are ever to know more of the real action of the earth-thrust behind retaining walls, of harmonizing the various formulas for the flow of water in pipes under pressure, of the actual stresses in masonry arches, and in many forms of girder, our knowledge is to come from those engineers who are not ignorant of mathematics. It is no argument against these studies that a number of ignorant men have succeeded in some of the simpler lines of construction work without more mathematics than they could pick up. In many instances the success of these men is due more to the ignorance of their patrons than to any ability they may possess.

In some primitive communities, the "yerb" doctor enjoys a reputation which could hardly fail to the lot of the best equipped modern graduate in medicine. It cannot be denied, however, that a very few men of unusual ability, have had enough energy and pluck to overcome their deficiency by their own, unaided efforts. These are the exception, however, and not the rule. Mathematics is often taught simply as a species of mental gymnastics, with

no other end in view than the discipline supposed to be acquired by the student under such instruction.

Since this method is calculated to kill all interest in live, practical students who have the making of engineers in them, it cannot be criticised too severely, and it undoubtedly defeats its own aim. To such students, mathematics possesses little interest outside of its capacity for solving the problems of the profession, and should be taught by an instructor who is himself an engineer, and who keeps the applications of his subjects constantly in view.

The suggestion that text books of pure mathematics be re-cast along lines which will bring them closer in touch with the profession is a good one. Yet the need of really practical text books in many lines of applied mathematics is much more serious. This lack of suitable elementary text books, and the necessity of having to scan large and loosely prepared special treatises, government reports, special monographs, etc., does not add to the thoroughness of the student, nor to his practical grasp of the subjects.

While saying a word for mathematical study, the writer agrees with Mr. Gould, that engineering students are often sadly lacking in real, practical knowledge of their profession.

The reasons why medical graduates are farther advanced along their profession than engineering students are not hard to see. The field of civil enginering is immensely broader than that of medicine, and, from the character of the work, progress must be much slower. Medical students have their clinics and often have opportunities to practice in hospitals, in charge of their professors. Engineering students have nothing exactly similar to this. They can make surveys during their course, draw up plans and specifications and execute drawings, but here their opportunities for acquiring practical knowledge cease, except for a limited number of inspection tours made by the class, to examine actual works in construction.

Mr. Gould's remarks on the difficulties in the way of determining just how far engineering should be taught as a science and how far as an art will strike a chord of sympathy in the breasts of all who are interested in the cause of sound technical training. The phenomenal success of some self-made men will convince the most skeptical that there are other requisites for an engineer besides a knowledge of mathematics and science.

Among these may be mentioned a mechanical turn of mind, good use of one's hands, financial ability, knowledge of human nature, capacity for managing men, and a sound, practical judgment. It will not be necessary to say that none of these qualities are supplied by theoretical training. Sound and thorough theoretical training is a necessity for ever becoming really practical in engineering. The other qualities enumerated above are necessities also. The one can be acquired in the schools, the others depend mostly upon the man himself, and can be fostered only by contact with the realities of the profession. The writer believes that the best results are attainable only when the theoretical and real sides of the profession can be carried hand in hand, or when conditions approximate to this. Under our present system this is not often possible in the schools. It is not likely that any material improvement in the work of the schools toward this end can be expected. The improvement must come through the students themselves, in working with field parties as rodmen, chainmen, etc., and in some capacity where they will see construction work in progress, before entering upon the technical work of the schools.

The amazingly rapid progress often made under these circumstances will also explain the success of the old apprentice system, of the correspondence schools and of many self-taught men. Respectfully,

J. N. Ambler.

Roanoke College, Salem, Va., Nov. 10, 1900.

Teaching Finance in Engineering Schools.

Sir: I note that the old differences of opinion on the merits of engineering education have again sprung into being with all of their old virulence of argument and I beg leave to shy my castor into the ring with a view of the matter which I have never seen touched upon.

The question arises: To what use is to be put the knowledge sent into the world from our engineering universities in the heads of numbers of young men as each summer brings a new graduating class upon the scene—are they all to be professors or instructors or experimenters? Do not some of them—a very large majority of them—expect to earn a living by the sale of the knowledge which they have gained? And are there not standing ready, financiers, eager to make use of and pay well for such knowledge—yes, hungry for it that they may the better keep their heads above water in the fierce competition of to-day—willing and anxious to pay always larger salaries for "better men" and never ceasing in their search for such?

What, then, is the difficulty—why the unbridged chasm between the two?

The conditions appear ripe for a happy and beneficial alliance, yet the financier regards askance the college graduate and the brilliant college graduate spends his life in some subordinate position devoid of opportunity and responsibility.

The reason appears to me to be a plain one, and it is that each speaks a language incomprehensible to the other.

Give us, say I, more higher mathematics, more long chemical determinations, more abstruse electrical formulae, let us never yield a hair's-breadth in our devotion and loyalty to more knowledge and better understanding, but Messrs. College Faculties give us these things in the brains of men who can express them in dollars and cents and you will give us men who though they may never have worked with their hands will yet be more practical than the best "shop man" (all credit to him nevertheless) who exists—lead ever your charges in the bright light of pure and higher engineering but amplify it with the side lights of "interest" and "depreciation" and "business risk" and "net earnings" and the distinction between practical and theoretical men will be reduced to nothing.

Very truly yours,

George K. Hooper.

73 Court St., Dedham, Mass., Nov. 12, 1900.

(On behalf of the technical schools it should be said that in many of them, we believe, the student is already taught to consider the commercial side of engineering questions, so far as such a subject can be taught in a school. As for the financier who is hungering to pay larger salaries to better men, we are glad to hear that such a "rara avis" really exists. But is our correspondent sure there's enough of him to go round?—Ed.)

Were Correct Deductions Drawn from the Bacterial Studies of Pavements at Lafayette, Ind.?

Sir: I have been much interested in reading the accounts of the experiments made by Professors Luten and Burrage to determine the healthfulness of different pavements, as detailed in your issue of Oct. 11.

Such experiments should always be encouraged, as their results give us facts upon which to base our theories, rather than glittering generalities. Great care must be exercised, however, in making our deductions lest an imperfect understanding or application of the conditions may produce results that are not in accordance with existing facts. For instance, one would hesitate some time before he would believe that a sheet asphalt or brick pavement is more unsanitary than one of decaying cedar block. Yet if the reasonings and deductions expressed in the article referred to are accepted one would be compelled to do so. Fortunately all the conditions of the tests are given in detail so that any one can intelligently deduce his own conclusions.

I would not accept unqualifiedly the principle laid down in the paper that the most unsanitary pavement is the one which transmits or allows to be transmitted the greatest number of germs to the human system. If pavements were never cleaned this statement might be more nearly true. Accepting and applying this principle, would it not prove the smooth tiled walls and floors of our contagious disease hospitals to be more unsanitary than if made of porous wood? It must be conceded that all germs coming from any pavement must be produced by the material composing the pavement or have been deposited upon it from extraneous sources. I would define, then, the most sanitary pavement as the one that contains the fewest disease germs and allows those falling on it to be most easily removed. Brick and asphalt, before being laid in pavements, are subjected to such temperatures as to destroy entirely all bacteria, and any germs coming from such pavements must have been brought upon them almost entirely by the elements or the traffic. And it is the province of the city officials to see that these are removed. While it is not expected that the street cleaners can pursue and capture every germ, it is a fact that if smooth pavements are properly cleaned comparatively few germs will be found floating in the air.

It would seem that the proper way to determine the relative number of germs on different pavements would be to ascertain the number in the same quantity of street sweepings taken from these pavements. In the experiments noted when the plates were exposed at midnight, when there was neither wind nor traffic, the resulting bacteria were macadam 9, asphalt 8 and 14, brick 16 and wood 50.

The reason why more bacteria (aside from the midnight tests.—Ed.) were obtained from the asphalt than any of the other pavements seems easy of explanation. It is an undisputed fact that it will require less wind to move dust on an asphalt surface than on one that is rougher, and why in this particular case there was more dust to be moved seems perfectly plain. The wood pavement had been laid eleven years and its condition can be easily imagined. It would have upon it no traffic that could possibly be diverted to other streets. Besides this, it was sprinkled twice each day. On the other hand, the brick pavements had been laid but a few years and were in excellent condition, while the asphalt had been laid the very year the experiments were made. Does it seem, then, a forced reasoning to argue that the large number of bacteria obtained from these streets was wholly on account of the increased travel that always rushes to a new asphalt pavement? Especially when it is remarked of the experiment that produced the greatest number of bacteria from the asphalt that the pavement was dry and the traffic heavy!

It must also be remembered that the streets experimented upon were parallel and in close proximity to each other, so traffic could easily take the line of least resistance. Also that it is stated that a large amount of mud was brought upon the pavement from the cross streets of macadam and gravel. In a city where all streets are paved with an improved pavement it is probable that very different results would be obtained.

It does not seem a natural conclusion from these experiments that an old cedar block pavement is more sanitary than asphalt or wood.

Geo. W. Tillson, M. Am. Soc. C. E.,
Principal Assistant Engineer, Department of Highways.
Brooklyn, N. Y., Oct. 19, 1900.

(In accordance with our usual custom, proof of Mr. Tillson's letter was sent to the authors of the article in question, and we append Professor Luten's reply.—Ed.)

Sir: Mr. Tillson in his communication regarding "Bacterial Studies of Pavements," draws a conclusion quite the reverse of that indicated by the experiments, basing his reasoning upon assumptions not warranted by the facts. Had he proceeded a step farther, he might have assumed that the wood block, being rougher and less easily cleaned than the sheet asphalt, would be the dirtier and dustier, and his conclusion would again have need of revision.

Mr. Tillson is in error in almost every statement made. The traffic upon the sheet asphalt was not heavier than upon the cedar block. The latter pavements are located in the business district, the former in the residence portion of the city. Records were kept of the number of teams passing during each exposure, but as no connection could be traced, the amount of traffic was not included in the report; it was, however, invariably heavier upon the cedar block pavements. The one instance of heavy traffic on sheet asphalt of Oct. 12, was an exposure on a dry, hazy day, with almost no wind, favorable to the accumulation of dust. On that day sheet asphalt gave 2,850 germs; brick, 99 germs. It probably shows that the absence of wind allowed the germs to be accumulated on the pavement, and that the lighter nature of the dust on sheet asphalt permitted them to be thrown into the air by the passing wheels. Macadam on that same day was muddy from a recent rain and gave few germs, as was to be expected.

The sheet asphalt pavements were smooth, and well-cleaned twice daily by broom and hand scraper. They were consequently nearly always clean, except for the fine dust which such methods of cleaning could not remove. The cedar block pavements, on the contrary, were rough, hard to clean, and consequently dirty—although not dusty, due to the nature of the surface of the pavement. The points at which exposures were made on sheet asphalt were about 800 ft. from the nearest macadam or gravel street. The exposures on wood block were made at points 200 to 500 ft. from a macadam street in bad condition, a continuation of the same street. Everything, therefore, was favorable to sheet asphalt.

A possible exception might be the fact that traffic moved more rapidly upon the asphalt, and that the wood block was sprinkled twice daily. Sprinkling at such long intervals would have availed nothing in allaying the dust on sheet asphalt. Nor would the wood block on sand foundation have become dry and dusty without sprinkling.

Analyzing the street sweepings from a given area can give no clue to the sanitary value of a pavement, since it fails to take into account the action of the wind, certainly an all-important element. The writers of the article in question attempted first to determine the number of germs upon the pavements in that way, but it was found that the amount of dust on a given area varied too much to admit of any conclusion. A gust of wind might increase the number of germs a thousandfold. The plan was therefore abandoned for the method described, designed to reproduce more nearly the conditions obtaining for a human being breathing the air over a pavement. The agar plates were consequently placed about 5 ft. above the pavement; the anemometer was placed close to the surface, because the amount of dust and germs thrown into the air by the wind would depend upon its velocity at the surface.

Mr. Tillson's definition of the most sanitary pavement as "the one that contains the fewest disease germs, and allows those falling upon it to be most easily removed" is the definition of an idealist. He says: "And it is the province of city officials to see that they are removed." The fact remains that city officials do not remove them. And it may even be doubted if it is practicable to do so. Note that the exposures of Nov. 25, on sheet asphalt, four hours after flushing, gave 755 germs, and eight hours after, gave 1,200 germs. The pavement had been thoroughly flushed by means of a stream from a fire hose, washing all dust and dirt into the sewer. Mr. Tillson states it to be a "a fact that if smooth pavements are properly cleaned comparatively few germs will be found floating in the air." Mr. Tillson would perhaps have the pavements flushed with an antiseptic fluid; certainly his

statement of fact is not borne out by the exposures on sheet asphalt shortly after a thorough flushing.

The results of the midnight exposures were to be expected. Wood block containing many germs, but not releasing them readily to wind or traffic, would give higher values at night than the other pavements, although far lower than the results of day exposures. Sheet asphalt, harboring fewer germs, gave lower values at night, but permitted more of them to be scattered to do harm, when wind and traffic appeared. It would seem as though all the experiments showed exactly what a careful reasoner on sanitary subjects might be led to expect. And the conclusions are based, not so much upon the results of the experiments, which were too few in number to be conclusive, as upon common-sense. Mr. Tillson mistakes the conclusion drawn in that article, which is not that sheet asphalt is always more unsanitary than cedar block, but that under the conditions that obtain in Lafayette, it is the more unsanitary pavement. And the conditions are carefully given in order that others may draw their conclusions regarding the pavements in other cities.

If it were practicable to keep the walls and floors of hospitals as damp as are cedar block pavements, or if porous wood were as easily fumigated as tiling, or if street pavements were kept as clean as an hospital floor, there might be an argument in drawing a parallel between the two. But street pavements in nearly all cities are cleaned very much as they are in Lafayette. And the writer believes that sheet asphalt and macadam, unless cleansed by frequent flushings, or by pneumatic sweeper, will be more unsanitary than asphalt block, brick, or wood.

It should be borne in mind that this entire discussion regarding the sanitary value of pavements must be from the germ standpoint alone. What effect cedar block, decaying and filthy, may have upon the health of human beings from other points of view, the writers have not attempted to determine. Daniel B. Luten.

Muskegon, Mich., Nov. 3, 1900.

Notes and Queries.

The Wallace combination cattleguard, illustrated in our issue of Oct. 18, should have been shown with V-shaped instead of rectangular troughs, the sloping sides affording no foothold to an animal, however persistently it might try to cross. This arrangement also gives a more substantial bearing for the ties. Mr. Wallace considers that it would be well to make these V-troughs of steel plate, the same as the shields over the ties.

A PNEUMATIC-TUBE MAIL SERVICE in Chicago is favorably recommended to the President by the commission appointed to investigate its desirability. The commission says that such a service would be practicable and beneficial to the Chicago post-office.

THE MOSQUITO AS A MEANS OF YELLOW FEVER infection is again to the front as the result of a report of a board of U. S. A. medical officers after studying the subject in Cuba. A preliminary account of the investigation may be found in the Philadelphia "Medical Record" for Oct. 27, 1900.

THE AMERICAN COPPER MINING INDUSTRY was never in so flourishing a condition, says a correspondent of the New York "Sun." It is estimated that between Jan. 1 and Oct. 1 of this year, 448,000,000 lbs. of copper were produced, worth from $72,000,000 to $75,000,000. Allowing 8 cts. per lb. for al expenses the net earnings for the nine months would be between $35,840,000 and $37,500,000. On the other hand, the nine months' profit as figured above, will nearly equal the total value of the home copper product of 1894. The foreign copper mines reporting only produced together 130,213,440 lbs. for the first eight months of this year; while the foreign deliveries for all Europe during that period amounted to 408,892,160 lbs. Under the existing enormous foreign demand the mining companies paid, for the year ending April 1, 1900, ranging from 8.1 cts. to 10.75 cts. per lb. of the total product refined; the dividends for the Calumet & Hecla Co., on an output of 98,824,000 lbs., amounted to $8,000,000, or $80 per share. The Boston & Montana Co. paid $5,400,000 on an output of 60,000,000 lbs. of copper, and other companies did proportionately well.

THE MARCONI SYSTEM of Wireless Telegraphy, says the London "Daily Mail," will shortly be reported upon favorably by the British Postal Departmental Commission, for use in connecting with the post-offices.

THE HEALTH OF THE ARMY OF THE UNITED States is given in the annual report of Surgeon-General Sternberg. Taking the army in the Philippines first, the report shows that out of a total of 60,554 troops, 8.47% were on the sick list on Aug. 31, 1900, or a total of 5,129 men. Malarial fever, dysentery and diarrhœa, account for 21.5, 14.4 and 16.4% respectively of 2,807 cases in the Manila hospitals. In the calendar year 1899, with a total strength of 105,546 regulars and volunteers, there were 229,885 admisions to sick report, equivalent to a rate of 2.178 per thousand of strength. In 1898 this rate was 2.146; and the mean annual rate for the decade 1888-1897 was 1.237 per thousand. The deaths in 1899 were 1,945, or a rate of 18.43 per thousand, as compared with 27.99 in 1898, and 6.69 for the average of the preceeding decade of peace. The troops serving in Cuba had the highest rate of admission to the sick list—2.747 per thousand, as against 3.423 per thousand in 1898. Troops serving in the United States showed an admission rate of only 1.677.

LIEUT. PEARY'S LAST ARCTIC EXPEDITION is reported upon by Dr. Leopold Kann, who landed recently in Dundee, Scotland, leaving Cape York, in June, 1900. Lt. Peary's party passed the winter at Etah, on Smith's Sound, not far from the scene of Greeley's disaster. In February and March, 1900, three parties visited Fort Magnesia, on Pym Island. Lt. Peary had 200 dogs and 27 sledges, but most of the dogs died from insufficiency of food, and Dr. Kann thinks Peary is now wintering at Fort Conger. He says that the Sverdrup party, in the "Fram," had thoroughly explored the Ellesmere hinterland, mapping out portions previously blank; and he proposed to explore the area of land and water around Jones Sound, beyond Cape Eden. He thinks Sverdrup is now wintering in Jones Sound, and that it will be impossible for the "Fram" to come home this season. Of this latter expedition Dr. Sveneden died June 9, 1899, and he is buried near Fort Magnesia.

THE CONSTRUCTION OF SUBWAY PIPE GALLERIES in connection with the New York rapid transit tunnel will be continued, the various city departments and the transit commissioners apparently having come to an understanding.

AN IMPROVEMENT IN BLOOMING MILLS, patented by Mr. Rudolph G. Beker, No. 649,108, May 8, 1900, and assigned to the Ohio Engineering Co., Cleveland, O., has for its object the increase of product of a single train of rolls. It is adapted to a two high reversing mill with feeding tables. Two ingots are placed tandem on the feeding table and rolled, one immediately following the other, in the first pass of the rolls; when sufficiently rolled in this pass the elongated ingots or billets are then brought side by side and rolled in two adjoining grooves of similar dimensions. The rolling is thence continued in like manner, the two billets going side by side through a pair of similar grooves. The new method of rolling requires only one-half as many reversals of the engines for a given tonnage of steel, and effects a great saving of time in rolling.

THE SOUTH CAROLINA INTERSTATE AND WEST Indian Exposition is proposed in a bill to be urged before the next Congress. The Senate has already favorably reported the appropriation of $250,000 for a government building and exhibits at such an exposition. It would be held in Charleston, S. C., from Dec. 1, 1901, to June 1, 1902. It is proposed to show the commercial and manufacturing advance of the South in the last 12 years, and one of the main features would be a textile building exhibiting the development of the cotton industry.

THE ARMOR PLATE QUESTION has been settled by an agreement of the Secretary of the Navy with the Carnegie and Bethlehem Companies, as follows: Krupp hardened armor plate is to be furnished to the government for $420 per ton, on condition that the government assumes certain liabilities as to the payment of royalties which will not make the armor cost more than $455.52 per ton in the aggregate. The above contract covers 24,950 tons of armor, and the extras assumed by the government include a royalty of $24.32 per ton for the Krupp process, and a U. S. license fee of $11.20 on the Harvey process, the Krupp process involving the Harvey patent. The armor bids opened last September called for 37,000 tons of armor and bolts and nuts, divided as follows: 24,950 tons of Krupp first-class armor, 10,250 tons Harveyized armor, and 1,000 tons nickel-steel armor; the bolts and nuts made up the aggregate. In the contract signed by the two companies mentioned their bids of September are accepted for the Harveyized armor at $411.20 per ton, and $400 per ton for the nickel-steel armor. If the case now pending, as to the validity of the Harvey patent, goes against the patent, the government will not pay the $11.20 per ton royalty. The total amount of these contracts is $15,087,800; or $16,004,024 if the government pays all royalties. It is said that France and Japan are now paying $700 per ton for Krupp armor.

ONE OF THE LARGEST CHIMNEYS in the State of New York, and probably in the country, has just been completed at the new power station of the Schenectady Locomotive Works by Contractor John McDermott, of Schenectady, N. Y., who is also the President of the Board of Water Commissioners of that city. The chimney is 200 ft. in height, and is 32 ft. square at its base. For nearly 40 ft. it rises perpendicular, and then assumes an octagonal form and gradually batters to 16 ft. in diameter at the top, where it flares and is surmounted by an iron cap 3 ft. high. The flue is 10 ft. in diameter. About 600,000 brick were used in constructing the chimney, which cost upwards of $16,000.

THE NEW NAVAL 12-IN. GUN, tested lately at Indian Head, gives the following very satisfactory record: With a charge of 360 lbs. of smokeless powder and an 850-lb projectile, the breech pressure was 16½ tons to the sq. in., and the muzzle velocity was 2,854 ft. per second. This is claimed to be the highest velocity ever attained by a 12-in. projectile; previous records ranging from 2,500 to 2,600 ft. per second. Forty guns of this type are ordered for our new battleships and heavy cruisers.

SEVERAL LARGE STEAMSHIPS intended to run from the Pacific coast to Oriental ports are being built by the Eastern Shipbuilding Co., of Groton, Conn. According to a New London news item these vessels are to be 630 ft. long, 73 ft. beam and 56 ft. depth of hold. They will be 20,000 tons register and 33,000 tons displacement, with five continuous decks running the whole length of the ship, with three additional partial decks amidships. The twin screws will be operated by triple expansion engines and water-tube boilers, and the vessels are to have a speed of 14 knots. They will carry 1,000 passengers in three classes, or enormous cargoes of coal, frozen meat, fruit, etc.

EXPORT STATISTICS OF THE UNITED STATES for 1900 will show the largest exports in the history of our foreign commerce, says the U. S. Treasury Bureau of Statistics. The total exports during October aggregated $163,093,597, or practically double the exports of October, 1894, and the total for the ten months ending with October is $1,194,775,205, again about double that of 1894. During this ten months exports exceeded imports by $499,667,936. For the first nine months of 1900 agricultural exports are $50,000,000 greater than for the same period in 1899; manufactures are $60,000,000 greater; mining products $7,000,000 greater, and forest products $5,000,000 greater. The greatest growth is in the export of raw cotton and manufactured iron and steel. Cotton exports for October alone amounted to $30,000,000; and manufactured iron and steel for the nine months ending in September aggregated $97,313,060, as compared with $76,569,205 for the same period in 1899, $59,990,665 in 1898 and $45,693,384 in 1897.

THE U. S. ARMY on Oct. 1, 1900, says the Adjutant General, was made up as follows: Officers, 2,535; enlisted men, 68,861. Besides these regulars there were then 1,548 officers and 31,079 men enlisted as volunteers; or a total of 99,023 officers and men, less 233 regular officers holding commissions in the volunteers. Under the law the present status comes to an end on July 1, 1901, unless Congress in the meantime provides for a permanent increase in the army, which it probably will do. While some demand an army of 150,000 to 200,000 men, the chances are that the weight of opinion will prevail and a compromise be made on 100,000. As showing the inadequacy of the old limit of 30,000, it is said that the home posts now empty will demand 25,000 men, to say nothing of those needed in the Philippines, Cuba and Porto Rico.

AUSTRALIAN JARRAH WOOD CROSS TIES are to be used to relay the Morelos Division of the Interoceanic Ry., of Mexico. According to press despatches the first cargo of 25,000 ties arrived at Vera Cruz early in November.

TWO INDUCTION COILS giving each a spark 42 ins. in length, representing about 400,000 volts, were exhibited by Queen & Co. at their rooms at 59 Fifth Ave., New York city, during a few days of last week. The coils have been ordered by the Japanese Government for use in experiments in wireless telegraphy, although the most successful work heretofore done in wireless telegraphy has been with spark lengths of only a few centimeters. The secondary of each of these coils contains about 125 miles of No. 32 copper wire wound in vertical layers, which are grouped in two large sections. The core consists of bundles of iron wire, weighing about 250 lbs. It projects about 15 ins. beyond the secondary at either end, the best length having been determined by experimentally plotting the field of force. The primary winding takes 20 amperes at 25 volts. The make-and-break apparatus is mounted upon a separate stand, which contains also the adjustable condenser. The break is made in a bath of alcohol between platinum button-shaped electrodes, the upper one of which is moved up and down by a cam movement driven by an electric motor. At the same time the lower button is slowly rotated. The frequency of the break may be varied from one to several thousand per second.

THE ORDNANCE BUREAU, through Gen. Buffington, Chief of Bureau, reports for the past year, summed up as follows: The Board of Ordnance and Fortifications has decided against building any more of the disappearing gun-carriages, ordered originally by the Endicott Board, when such a carriage was deemed highly important by military

authorities. The War Department has already adopted balanced pillar-mounts for 5-in. guns, and is making the same for 6-in. guns, with similar mounts contemplated for still larger calibers. The report complains of delays in furnishing 15-pdr. guns and carriages by the Driggs-Seabury Co., though this company has delivered 57 15-pdr. and 20 6-pdr. guns. A similar complaint is made against the contractors for the Brown segmental wire gun. During the last year heavy guns were completed as follows: Ten 10-in. and 24 12-in. rifles, and 38 12-in. mortars, making a total of 658 heavy guns now ready for our defences. Work on the 16-in. rifle has been delayed by the need of a larger furnace. During the year 5,590 armor and deck-piercing projectiles were accepted. Contracts have also been made for 1,151,000 lbs. of smokeless powder, of which 800,000 lbs. were for the use of seacoast guns and mortars. It is believed that the new powder is satisfactory. Notwithstanding many experiments in firing shells containing wet guncotton, thorite, jovite No. 2, corborite and lyddite and ammonia nitrate compounds, the explosive of this type safe in the gun and in storage is yet to be found. The bureau expended during the year $16,240,785.

BOOK REVIEWS.

THE ELECTRO-MAGNETIC TELEGRAPH.—By A. E. Loring. 4th edition, revised. New York: D. Van Nostrand Co. Cloth; 4 × 6 ins.; pp. 116; illustrated. 50 cts.

This is a manual of the Morse electro-magnetic telegraph prepared for the benefit of practical operators and students of telegraphy. It discusses the fundamental principles of electricity and magnetism, describes the Morse telegraph, and the quadruplex, gives directions for the care of batteries and the construction of lines and much other information useful to the practical telegrapher. On page 83 there are a number of errors in the Morse code, which should be corrected.

THE MANAGEMENT OF DYNAMOS.—A Handbook of Theory and Practice for the Use of Mechanics, Engineers, Students and Others in Charge of Dynamos. By G. W. Lummis-Paterson, E. E. 2d edition, revised and enlarged. New York: The Macmillan Co. Cloth; 5 × 7½ ins.; pp. 262; 103 illustrations. $1.75.

The practical care and management of direct-current dynamos is treated in a very useful manner in this book. It discusses the various ways of connecting up machines, the troubles likely to be met with, and the means to be used in avoiding or overcoming them. There is no reference whatever to alternating current machines. The first three chapters are devoted to electro-magnetic theory, but parts of the matter there presented would, it appears to us, be of very little use to the beginner or to any one else. However, the part of the book relating to practice is to be commended.

A TREATISE ON HYDRAULICS.—By Mansfield Merriman, Professor of Civil Engineering in Lehigh University. Seventh edition. New York: John Wiley & Sons. Cloth; 6 × 9 ins.; pp. 427; illustrated. $4.00.

In this latest edition of this standard treatise on hydraulics attention is called to the recent experiments of Marx, Wing and Hoskins on flow in steel and wooden pipes, and to those of Bazin upon flow over dams. As the previous edition took up the results of Herschel's gagings of the flow in riveted pipe and Bazin's new formula for flow in open channels, the student now has before him the very latest formulas and experiments on these subjects. Important changes have also been made in the presentation of the matter relating to the compressibility of water, the flow from a revolving vessel and the mean velocity in a channel. Several formulas and statements have been replaced by better ones, and the book is now fully abreast with modern progress in hydraulics and better adapted to its purpose as a text-book for engineering students.

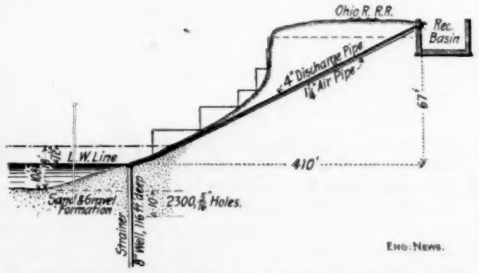
RAILWAY SIGNALING.—By H. Raynar Wilson, of the Lancashire & Yorkshire Ry. London, "The Railway Engineer." Cloth, 4to; pp. 160; illustrated. 19 shillings ($4.75).

The title to this book is a little misleading, as it would naturally imply that it covered the principles and practice of signaling. As a matter of fact, the book deals only with signal apparatus and has nothing to do with the operations of signaling. The first chapter deals with staff and tablet apparatus for single-track working, including devices for exchanging the staff or tablet. About 22 pages are then devoted to signal cabins and the details of their carpentry and masonry work, fittings, etc., independent of the equipment for operating signals. The chapter on "Signals" describes the construction of iron and wooden posts, bracket posts, semaphore arms and spectacle castings, slot devices, dwarf signals, signal bridges, etc. Two half-tone engravings show a double-deck bridge at Rugby (London & Northwestern Ry.) each deck having 13 posts of different heights and 22 blades. Many of the semaphore blades have disks or rings attached. The chapter on signal and point connections describes various forms of rod and wire carriers and couplings, locking or detector bars, facing-point locks, etc. Locking frames are then described, followed by a chapter on the arrangement and location of signals, and the preparation of locking lists. Interlocked gates for grade crossings are then dealt with, and the book closes with some plans of large signaling installations at yards, junctions and terminals. The book is profusely illustrated, there being some 500 cuts, a great number of which are reduced working drawings of apparatus and details, and throughout the book the various mechanisms are described with great minuteness. The book is well printed on highly calendered paper, but though the illustrations are clear, the lines are weak and ragged, having apparently been drawn too lightly in the first place. The index is fair.

MOVING WATER HORIZONTALLY BY AIR LIFT PUMPS AT POINT PLEASANT, PA.

Air lift pumps are common enough nowadays, but so far as we know they were restricted to the vertical movement of water until within the present year. The exception to this rule is located at Point Pleasant, Va., and was described in a recent number of "The Metal Worker," by Mr. Clark Howell, of Charleston, W. Va. The water supply is drawn from the gravel beneath the bed of the Ohio River, through 8-in. driven wells, sunk 116 ft. below the minimum water level and connected with a receiving reservoir by 4-in. discharge pipes, rising 67 ft. in a distance of some 400 ft., as shown by the accompanying section. The illustration has been redrawn from "The Metal Worker," and the following account of the plant has been condensed from Mr. Howell's article in the same journal:

All the machinery was located above the highest known flood line, which is over 60 ft. above the lowest river stage (U. S. zero gage). The franchise granted the water company was for a combined water and electric light plant, and specified that water was to be taken from the Ohio River. The most desirable site obtainable for the works was about a mile above the town, but the Ohio River Railroad tracks at this point were too close to the river bank to permit the erection of the works on the river side of the railroad. The power and pumping house



Air Lift Pumps for Moving Water Both Vertically and Horizontally, at Point Pleasant, Va.

had therefore to be located about 200 ft. distant from the top of the bank, about 400 ft. laterally from low water point in the river and 67 ft. above it, as shown in Fig. 1.

To have constructed a pumping well of sufficient depth and size to accommodate pumps to draw water from the river channel at zero stage and a tunnel to the river would have made the cost of the works so great that sufficient capital could not have been secured to erect them. Some other and less expensive system had to be adopted. Manufacturers of water-works machinery were consulted and various plans and systems considered. Finally it was determined to adopt the air lift system, and a hydraulic engineer was employed to make specifications and plans. He proved so unreliable or ignorant of what was required that his services were dispensed with.

The Howell & Shanklin Construction Co., of Charlesfon, W. Va., was then invited to submit plans and specifications. These were promptly adopted, and a contract was made with it to erect the works entire, which were completed to the last detail just as planned and specified by it.

The use of the air lift system would require wells deep enough to obtain a submergence sufficient to overcome the 67-ft. bank lift, plus the depth of the wells and friction of about 500 ft. of discharge pipe from the wells to the receiving basin placed obliquely up the river bank. Just here the algebraical x in the problem was found.

At a meeting of the Central States Water-Works Association, held in Cincinnati, September, 1899, the writer sought information regarding the application of the air lift system to such situations.

When it was stated that it was the intention to take water from wells sunk in the channel of the Ohio River and discharge it into a basin situated as described, the discovery was made that the problem was not only new but of very doubtful solution. There was no reliable information obtainable from that source on this particular feature of the enterprise.

Later, an engineer, representing one of the oldest builders of air compressors and who has had many years' experience in this line, after a personal examination reported the situation to his firm, who declined to furnish machinery with any guarantee of success, because of the probability that when the air reached the sloping pipe up the bank it would pass the water and escape, the water returning to the wells.

Nothing daunted, the contractors proceeded with the works. Presuming that the wells would always be full if located and sunk at low water line, it was decided to make them 110 ft. deep. The calculation was based on 60% submergence as being ample to overcome both lift and friction.

Careful soundings of the river channel were made, and it was found that there were several feet depth of sand and gravel forming the river bottom at this point. Well casing 10 ins. inside diameter was driven to the rock, about 40 ft. in depth. This casing was perforated with hundreds of ¼-in. holes, commencing at about 10 ft. from the top and extending about 10 ft. downward. After the 10-in. casings were in place 10-in. holes were drilled in the underlying rock 116 ft. deep and cased 8 ins. inside diameter from bottom to top. This casing was also perforated similarly to the outer one, only the holes were larger—5-16-in. The space between the two casings was tightly calked at the top to prevent water entering the wells at this point. Four-inch discharge pipes and 1¼-in. air pipes were properly fitted and suspended in each of the wells, with their extremities 110 ft. below the top of the 8-in. casing.

Both pipes were suspended from a water tight cap, resting on the top of the 8-in. casing. No water can enter these wells except through the perforations in the casings, which are 10 to 20 ft. below the flowing water in the river. None can enter at the bottom. It was the desire to allow the river water to enter the wells only through the perforations after having passed through the sand strata mentioned, which would serve as a filter. Before proceeding further I wish to state that this feature has proved successful beyond expectation. However muddy the river may be, the water taken from the wells is bright and sparkling at all times.

Just when the wells were completed and the pipes in place, and extended up the sloping river bank a short distance, the river rose over the wells. The pump and air compressor builders were weeks behind promised delivery, and for two months the wells stood unused as described. In the meantime the reservoir, receiving basin and power house were completed and the work advanced as fast as possible. Just as soon as the air compressor was in place the air pipes were connected up and the wells tested before the discharges were extended to the receiving basin. One well was found with a deposit of sand in the bottom, reaching 5 ft. above the foot of the discharge pipe. Several unsuccessful efforts were made to force air into this well. The river having receded, the air pipe was disconnected at the top of the well and a ⅜-in. gas pipe coupled and lowered. It stopped 5 ft. from the bottom. It was churned a few minutes and soon went down the remaining 5 ft. Again the air pipe was coupled and the air pressure increased to 90 lbs. per sq. in. The effect was almost startling, but gratifying. The obstruction was cleared out very quickly. No other system of pumping could possibly have accomplished the clearing out of this well of the sand deposit.

The discharge and air pipes to each well are independent. That is, each well has a separate discharge to the receiving basin and a separate air pipe from the receiver. These are carefully graded and are not exposed at any point, except where the discharges pass through the top of the walls of the receiving basin, and have open discharge.

The power house is a good substantial brick structure immediately alongside the Ohio River Railroad. It contains the steam boilers, a 200-HP. Corliss engine, electric dynamos, air compressor and forcing pump. All the machinery, both pumping and electric, is belt driven from friction clutch pulleys on a line shaft. All the machinery is very substantial and capable of performing its duty without strain. The air compressor is 14 × 18 ins. with mechanically operated valves. It is speeded to 96 revolutions, and has a capacity of 312 cu. ft. of free air per minute. The required working pressure is from 45 to 50 lbs., varying with different river levels.

The discharge of water is not constant, however, but irregular or intermittent, as though the air and water formed alternate strata or volumes within the discharge pipes. It varies with the depth of water in the river, ranging from 1 volume of water to 8 volumes of free air, to 1 to 6. As the river is constantly rising and falling and frequently is 25 to 40 ft. deep over the wells, the pressure on the sand surrounding the wells is constantly changing and affects the capacity of them as well as the necessary air pressure to pump them.

The reservoir is situated about 1½ miles distant and at 225 ft. elevation. It is built of vitrified paving brick laid in Portland cement with 18-in. concrete bottom and roofed over with slate. Water is taken from the receiving basin by belt driven triplex outside packed plunger pumps, 9 × 12 ins., operated at 37 revs. per min., delivering about 22,000 gallons per hour.

As there is no demand in the town for electric current during the day, the works are operated at night only. Usually the air compressor is operated one night, and the following night the forcing pumps. The water

received the previous night in the settling or receiving basin has about twelve hours to become cleared of any sand brought with it from the wells before going to the reservoir. This basin has a capacity of about 225,000 gallons; the reservoir about three times this quantity. The construction of the receiving basin is the same as the reservoir. The engine has ample power to operate all the machinery at the same time. Two men only are required to attend the combined plant. The entire plant, including power house, lot, reservoir site, rights of way, mains, hydrants, wells, lines, machinery, arc light, all included, cost $55,000. In addition to the public and private consumption of water, two busy railroads are consumers. All customers are served by meter and therefore there is practically no waste.

There can be no doubt that water taken by air in this manner is purified to some extent, the admixture of air serving to oxidize and destroy organic matter. Samples of the water taken last January are still bright and sparkling, have no odor and remain apparently unchanged. There probably is not another town of 5,000 inhabitants in the country that has a better or more complete combined water and light works. Certainly there is not another town of any size on the banks of the Ohio River from Pittsburg to Cairo that has better water, if as good.

The works have been in constant operation since January last and have been visited by many interested parties. The system demonstrated at Point Pleasant will beyond a doubt be repeated elsewhere. That it is regarded as a paying enterprise we have but to repeat the president's statement made to the writer a week ago, "There is no stock for sale, and not a single share was sold at less than par." The pump and compressor were built by the Stilwell-Bierce & Smith-Vaile Co., of Dayton, Ohio.

What has been accomplished at Point Pleasant can be done at hundreds of other small towns similarly situated where there is no water-works. Here it has been demonstrated that bright, sparkling water can be obtained from a muddy, filthy stream without the use of chemicals or mechanical filters.

INVESTIGATION AS TO VIRTUAL GRADES; CANADIAN PACIFIC RY.

By A. C. Dennis.*

The subject of virtual grades is of considerable importance to the railway engineer, and one which deserves more attention than it has generally received. The accompanying diagrams were used in determining the value of momentum in connection with the proposed reduction of grades on the Ontario & Quebec Division of the Canadian Pacific Ry. The present line between Montreal and Toronto has maximum grades of 1% in both directions, which, being uncompensated for curvature, are equivalent to about 1.12%. The gross westbound tonnage, including locomotives, is about 62% of the eastbound; and it is proposed to balance the grades to conform to the tonnage by reducing the eastbound to 0.6% compensated, without any reduction in the westbound grades. With such grades, the locomotive rating behind the tender will be 1,600 tons east, as shown on the diagram, and 900 tons west. The latter will usually be somewhat reduced, because the westbound trains are composed largely of empty cars, which offer a greater resistance per ton than loaded cars.

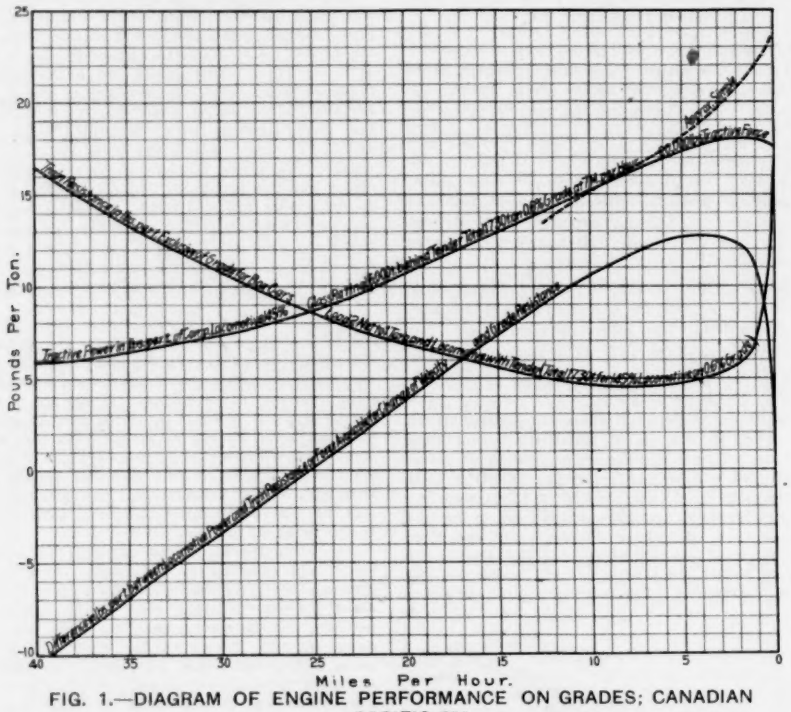


FIG. 1.—DIAGRAM OF ENGINE PERFORMANCE ON GRADES; CANADIAN PACIFIC RY.

The assistance in surmounting heavy grades which may be derived from the momentum of a train at high speeds is almost universally understood, yet engineers usually hesitate to adopt a virtual profile, notwithstanding that one may be practicable which would utilize the energy that has been stored in the train. Mr. A. M. Wellington, in discussing the subject, assumed that the tractive power of the locomotive and the train resistance remain practically constant at different velocities. This, as is well known, is far from correct; and the error which is introduced by this assumption increases as the grade increases over that for which the train is rated.

The diagram in Fig. 1 is designed to represent the performance of an engine loaded for an ascending grade of 0.6%, at 7 miles per hour, on grades from 0 to ± 1.1%, with velocities ranging from 0 to 40 miles an hour. The three curves are as follows: (1) The tractive power (in pounds per gross ton at different speeds) of the 145% freight locomotive in use on the Montreal and Toronto section of the Canadian Pacific Ry.; (2) the train resistance curve, taken from Wellington's experiments with loaded cars; (3) the curve representing the algebraic difference of the first two curves or the force available for accelerating or retarding the velocity of the train. The latter, when reduced to its equivalent gravity resistance in rate per cent. and added (algebraically) to the actual grade, is the rate per cent. of acceleration or retardation. This rate per cent., divided into the difference of velocity heads, gives the distance in which that change of velocity is accomplished. With these distances the diagram shown in Fig. 2 is plotted.

The accompanying table shows how the computation was made from the curves in diagram 1. The table as printed covers only the speeds from 1 to 10 miles per hour, and grades from — 0.5% to + 0.5%, and is inserted only to show the method of work. The manner of extending the table to include the same range of speeds and grades as the diagram will be obvious.

As an example of the use of the diagram, in Fig. 2, suppose we have a descending grade of 0.2%, one mile long, beyond which is an ascending grade of 1.0%, and we desire to know how far up this 1.0% grade an engine can haul a train loaded for an ascending grade of 0.6% grade and arriving at the top of the 0.2% grade with a velocity of 10 miles per hour. Following the vertical line in the diagram, representing 10 miles per hour, it intersects the — 0.2% grade at the horizontal line representing 200 ft. The point where the 5,280 + 200-ft. line intersects this same grade corresponds to 25.3 miles per hour, which is the velocity the train will have acquired at the foot of the + 1% grade.

*Divisional Engineer of Construction, Canadian Pacific Ry., Toronto, Ont.

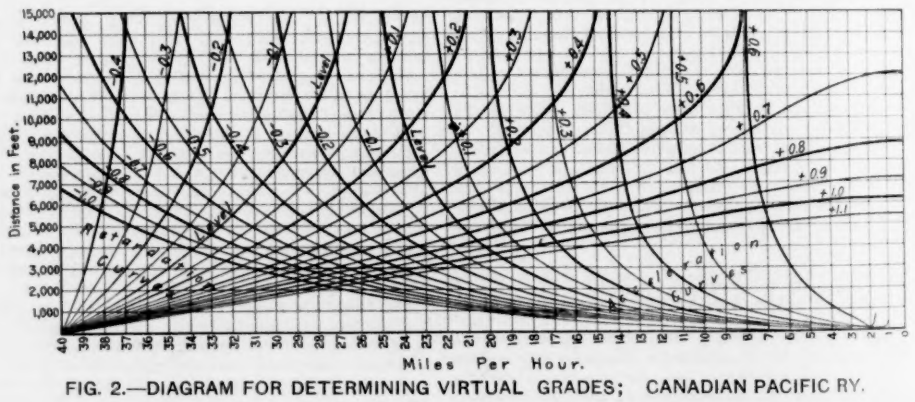


FIG. 2.—DIAGRAM FOR DETERMINING VIRTUAL GRADES; CANADIAN PACIFIC RY.

Distances in Stations for Various Changes of Velocity on Grades Shown for 145% Locomotive Working Compound and Hauling Full Rating for 0.6% Grade.

Speed miles per hour.	Tot'l ve- locity head.	Diff. in velc- ity h'd	Diff. lo- cmtve work and train resist- ance†	Grade equiv- lent to same %	Grade per cent. — 0.5 D.	T.	— 0.4 D.	T.	— 0.3 D.	T.	— 0.2 D.	T.	— 1.0 D.	T.	Level. D.	T.	+ 0.1. D.	T.	+ 0.2. D.	T.	+ 0.3. D.	T.	+ 0.4. D.	T.	+ 0.5. D.	T.
					Distances in stations.																					
1	0.04	0.04	8.0	— 0.40	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2	.14	.10	11.8	— 0.59	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.5	0.5	1.1	1.1
3	.33	.19	12.6	— 0.63	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.3	0.4	0.3	0.5	0.4	0.6	0.4	0.6	0.6	0.9	0.8	1.3	1.4	2.5
4	.56	.23	12.8	— 0.64	0.2	0.5	0.2	0.5	0.2	0.5	0.3	0.6	0.3	0.7	0.4	0.9	0.4	1.0	0.5	1.1	0.7	1.6	1.0	2.3	1.6	4.1
5	.88	.32	12.8	— 0.64	0.3	0.8	0.3	0.8	0.3	0.8	0.4	1.0	0.4	1.1	0.5	1.4	0.6	1.6	0.7	1.8	1.0	2.6	1.3	3.6	2.3	6.4
6	1.26	.38	12.6	— 0.63	0.3	1.1	0.4	1.2	0.4	1.2	0.4	1.4	0.5	1.6	0.6	2.0	0.7	2.3	0.9	2.7	1.2	3.8	1.6	5.2	3.0	9.4
7	1.71	.45	12.4	— 0.62	0.4	1.5	0.4	1.6	0.5	1.7	0.6	2.0	0.7	2.3	0.7	2.7	0.9	3.2	1.1	3.8	1.4	5.2	2.0	7.2	3.7	13.1
8	2.24	.53	11.6	— 0.59	0.5	2.0	0.5	2.1	0.6	2.3	0.7	2.7	0.8	3.1	0.9	3.6	1.0	4.2	1.3	5.1	1.8	7.0	2.8	10.0	5.9	19.0
9	2.83	.59	11.4	— 0.57	0.5	2.5	0.6	2.7	0.7	3.0	0.8	3.5	0.9	4.0	1.0	4.6	1.2	5.4	1.6	6.7	2.2	9.2	3.5	13.5	8.5	27.5
10	3.55	.72	10.8	— 0.54	0.6	3.2	0.7	3.4	0.9	3.9	1.0	4.5	1.1	5.1	1.3	5.9	1.6	7.0	2.0	8.7	3.0	12.2	5.1	18.6	18.0	45.5

D. stands for difference, and T. for total distances, in stations. †Difference of locomotive work and train resistance, or force in pounds per ton available for changing velocity or overcoming grade resistance.

The speed of 25.3 miles per hour on a + 1% grade corresponds to a distance of 2,800 ft.; 0 miles per hour on the + 1% grade corresponds to 6,200 ft. The train, would, therefore, stall at (6,200 — 2,800) = 3,400 ft. from the foot of the grade, or would run (5,800 — 2,800) = 3,000 ft., before its speed would be reduced to 7 miles per hour. This distance (3,000 ft.) can, therefore, be operated as a virtual + 0.6% grade, beyond which point the grade must be reduced to an actual + 0.6% grade. Experiments made within rather narrow limits of velocity and grade checked very closely with calculations made on the above basis.

It is obvious that a locomotive with a tractive power curve which decreases less rapidly as the speed increases can be operated more favorably as regards momentum grades, so it is important that such grades be calculated for the most unfavorable class of engine likely to run on that section.

In considering the question of reducing the grades on the Montreal and Toronto section, it is found that by the assistance of momentum grades only about 30% of those exceeding the new ruling grade of 0.6% will require to be reduced, or that it will be necessary to rebuild only about 10% of the line; whereas, to reduce these to actual 0.6% grades, as much as 30% of the line would have to be rebuilt. From this it is evident that much of the work usually done in reducing grades to a lower common rate per cent., without utilizing the momentum which has been acquired by the train, is practically useless expenditure. The subject is certainly one which offers a profitable and interesting field for experiment and study by the man who draws the red line on the profile.

THE EXPLOSION AT THE RED-ASH COLLIERY, FAYETTE CO., WEST VIRGINIA.*

By W. N. Page, M. Am. Soc. C. E.†

The Red-Ash colliery was the scene on March 6, 1900, of an explosion by which some 50 men were killed or wounded, and much property was injured or destroyed. On March 19, the earliest date at which entrance was practicable, I examined the mine with the view of determining the extent, cause and point of origin of the explosion, and with the permission of Mr. F. Howald, the manager, and the owners of the property, for whom the examination was made, I present in this paper some results of that examination, comprising the essential portions of my report to them.

LOCATION AND PLAN OF THE MINE.

The Red-Ash colliery, situated on the south side of New River, next below the Rush Run mine, with which the underground workings are connected, is a drift-mine, the entrance to which is on a slope, about 500 ft. above the river. The accompanying cut is a plan of the workings.

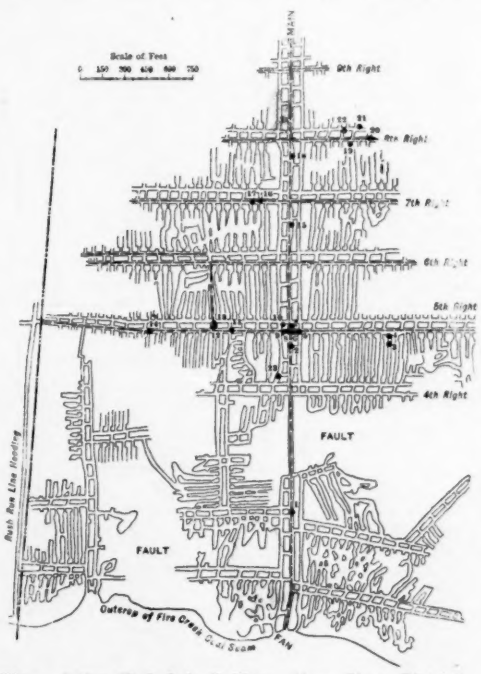
The main entry has been driven north about 4,000 ft. from the surface, with parallel entries on either side from the fourth set of cross-entries and about 70 ft. of chain-pillar between the parallels. Except where interrupted by a squeeze (marked "Fault" on the plan) cross-entries have been driven east and west at intervals of 400 ft., with parallel air-ways, constituting a complete double-entry system, remarkably regular and uniform, aside from the squeeze referred to. About 75 ft. west of the entrance, an exhaust fan, built by Messrs. Thayer, of Charleston, W. Va., is located in the mouth of the parallel air-way on the left or west side of the main entry, which parallel is broken by the squeeze, but connected at the fourth set of cross-entires, through workings to the westward, giving about the same effect as if the air-way had been continuous. I did not measure the efficiency of this fan; but the mine-workings have been planned for an excellent system of ventilation, which should be ample for every requirement with any standard centrifugal machine proportioned to the work. The fan is driven by compressed air, which is frequently used for such purposes, and I understand that several others of the same model and make are employed in the district, giving satisfactory results. Under the plan of ventilation, the main entry is the intake, with an average cross-section of about 6 by 12 ft., or 72 sq. ft. of area, which is more than enough for the safe working requirements of the mine. The current is directed to the head of the intake where it is split, and conducted across the face of the workings to the east and west through a system of trap doors, brattices and stoppings; that on the east returning through an overcast at the fourth cross-entry. With the double entries and break-throughs from room to room, as shown on the plan, there is no reason why the circulation should not have been as nearly perfect as any artificial system of ventilation can be made, as the entries and air-ways are unusually straight, with ample cross-sectional areas to reduce friction and resistance to a minimum. I feel safe in saying, therefore, that if there was lack of circulation at the time of the explosion, it cannot be attributed to any defect in the system or the general plan of the mine-workings.

*From a paper for the Canadian Meeting of the American Institute of Mining Engineers.

†President and General Manager Gauley Mountain Coal Co., Ansted, W. Va.

EXTENT AND EFFECT OF THE EXPLOSION.

The main entry showed no evidence of unusual heat or flame, beyond what might be expected along the intake, from an ignition of gases in some other part of the mine; the heated air and flame being necessarily thrown toward this entry, as offering the line of least resistance to daylight. Beyond the ninth cross-entries, the force had been exerted toward the face or inward, and from these entries, outward, everything had been swept toward the entrance like shot from the barrel of a gun—to which this entry may be likened, the expanded air and gases in the extensive workings representing those of the enlarged powder-chamber of the gun. From the 5th cross-entry there were three escapes for the pressure they produced, the main entry being the shortest and the only straight one. A second was the parallel air-way on the west (left) which turned squarely to the west at the 4th entry, and had to pass through the "squeeze" by a devious route before reaching daylight at the fan, which also operated to obstruct this outlet. The third way was down the west 5th entry to the Rush Run workings. Between these and the Red-Ash there was a brattice, or stopping, which was



Plan of the Red Ash Colliery, New River District, W. Va.
(Numbers designate points where bodies of those killed by the explosion were found.)

blown out; and in addidon to which there must necessarily have been, in that direction, other resistance due to old workings.

The walls and roof of the main entry were covered with white dust from the floor, showing that the clay in the tracks and road-beds had been swept through this channel with considerable force. At the 4th cross-entry the overcast timbers were blown straight down, showing that the contracted area of the stone drift through the squeeze had dammed back the force and equalized the pressure from the east workings, the return from which was through the overcast at this point.

The 4th cross-entry east shows the effect of heat, as if it had been filled with flame, the ribs and roof being covered with coked dust. The indications here also point to the conclusion that the forces were dammed back by the stone drift, which probably gave the flame more time for action. At the 5th, 6th, 7th and 8th cross-entries the doors on the west were blown in and down the main entry toward daylight; while those on the opposite side were thrown eastward toward the faces of the workings. The door of the 8th west entry was found several hundred feet down the main entry toward No. 7, and the six men found at point 18 on the plan, as well as the cars wrecked there, evidenced a violent force from the west, coming down this 8th cross-entry. On the main entry at No. 2 west, five bodies were found badly mangled and burned. As this point is near the beginning of the stone drift, the force and heat were probably concentrated by the contracted area inside, but had room to expand through the old workings toward the outcrop before reaching the entrance. No. 5 east showed heat and coked dust due to flame, but little effect of the explosive force, which appears to have been directed up the entry from the main to the 8th or 9th room. Enormous forces were exerted down the 19th and 20th rooms, coming from the direction of No. 4, with which they were connected by break-throughs. The tracks and everything movable, including a Harrison mining-machine, were thrown out of these rooms against the rib of No. 5 entry, where the force seems to have been divided, one part being directed toward the face of the entry, the other toward the main entry.

Entries 6 and 7 east, as already observed, had their doors blown eastward, showing that the force originated in or beyond the main entry and not in these east workings, in which there is little evidence of violent disturbance, though coked dust on the walls and roof shows flame and heat. No. 8 east was little disturbed by heat or force, especially near the faces of the workings; and I am confident that the explosion did not originate in these or any other workings east of the main entry. The body of a man was found on No. 8 east at point 19, in the mouth of the fifth room, to reach which he must have passed within sight and hearing of the fire-boss, who was found at 20, only about 100 ft. distant on the same entry at the 7th room and 5th break-through. It is evident that the latter had found gas in the face of this entry, as he had raised the end of the air-pipe and turned on the air to drive it out; but it is reasonable to assume that he did not regard it as dangerous, or he would not have permitted the presence of the three men found so near, one at 19, one at 21, and one at 22, all of whom he probably saw or heard enter. I was informed that none of these four men were burnt or disfigured, and from descriptions of their position and condition, I infer that they must have been killed by the after-damp resulting from the explosion.

The faces of the main, parallel and cross-entries No. 9 all show the effects of considerable force coming up the west parallel from No. 8; and the intersection of this parallel with No. 9 west is indicated as the point at which the greatest force of the explosion was exerted within the mine. On entry No. 8 west, near the mouth of the second room, the waves of force were projected in every direction; the track and timbers having been thrown east and west on the entry, and north and south through the rooms and air-ways. As no other point in the mine exhibited like conditions, it is reasonable to asume this as the origin of the explosion; and, in my opinion, the gas was first lighted at or near this point. Everything was swept through this room to No. 7 entry with great violence; the indications being that the forces directed south through this room, east to the main entry, and north up the parallel air-way, were about equal, while that along the entry to the west was breeched by the faces of the workings, distant only a few hundred feet in that direction. All indications in the west workings point to the movements of the forces from that point to daylight along the lines of least resistance, through rooms, air-ways, and main entry, and along No. 5 west, in both directions; eastward to the main entry, and westward to the Rush Run mine. At point 16, on No. 7 west, a boy was found in line of the room already referred to, leading from No. 8. Near by, at 18, another boy was found.

CAUSE AND ORIGIN.

The primary cause of the explosion was evidently fire-damp, a carburetted hydrogen gas, the principal constituent of which is CH_4, or marsh-gas. We know that a mechanical mixture of more than one part of this gas to 14 of atmospheric air is explosive—the most explosive proportion being about 1 : 9.5. With more than 15 or less than 5 parts of air to one of gas, the mixture is not explosive; but by reason of the diffusion of gases, this mixture must always be found variable where there is any ventilation or circulation of air. As all coal will give off at least its own volume of gas (and some coal much more), its presence is easily accounted for, and would be detected in all coal mines, but for its tendency to escape through every crack and crevice toward higher outlets, owing to its density being less than that of air. Taking the density of air as unity, that of methane, or marsh-gas, is 0.559, or a little more than one-half as great. If sufficient time is allowed, air and fire-damp will make a complete mechanical mixture, according to the law of diffusion of gases; but the latter is usually found at the top in mine-workings, owing to lack of time for complete diffusion before the gas is removed by natural or artificial ventilation. In coal-mines above water-level, where the covering can crack, or break, fire-damp is rarely noticed in workings within less than a mile of the escarpment, or outcrop. Within this limit it is carried off by the usual methods of ventilation, assisted by the movement of cars, the upward escape by levity, through crevices, etc.; but below water-level, or where the lines of escarpment embrace larger areas, with a heavy, unyielding cover, gas may usually be expected to give more or less trouble..

At Red Ash there is no escarpment northward or westward, in the direction of the workings, for many miles, and the overlying rocks are too massive to break, in consequence of which gas had been found within 4,000 ft. of the entrance, and was probably given off freely in all the workings inside and including the 8th cross-entry. During a period when the fan was idle on Monday night, there must have been in these workings an accumulation of gas and a mixture of it with air, which by the operation of the fan on Tuesday morning was started back in the return air-course, where it was met by a naked light on the 8th west entry near the main return air-way.

About sufficient time (30 minutes) had elapsed, since the starting of the fan, for the air to travel down the intake, 4,000 ft. of the main entry, and back on the return to the point indicated—the total travel being about 4,500 ft., which would make the velocity about 150 ft. per minute, and (taking the section of main entry at 72 sq. ft.) would be equivalent to a volume of nearly 10,800 cu. ft. per minute—probably as much, or more than as much, as the fan was doing on the start.

The theoretical requirements for ventilation given by André, in his "Practical Treatise on Coal Mining," a standard authority for the world, are 24 cu. ft. of air per minute for each man and light, 72 for each horse, 192 for each pound of powder burned, 100 for each cu. ft. of coal mined, and 1 cu. ft. per minute for each square yard of coal-surface in the mine.

Assuming that 150 men were employed underground in the Red-Ash colliery, with 15 horses or mules; that 12 lbs. of powder were burned per hour, and 18 cu. ft. of coal were mined per minute (or 400 tons in 10 hours); and that 1,000 square yards of coal-surface was exposed, a simple calculation will show that 10,000 cu. ft. of air per minute would be required to satisfy André's requirements. But this would leave no factor of safety, whereas such a factor, of 2 to 5—according to actual tests of the amount of gas produced in the mine—should be allowed.

From the effects observed, I think the dust had little or no influence on the primary cause, though it must necessarily play an important part in all explosions, when the gas is once ignited, by adding to the forces evolved. My impression is that the boy found on No. 7 west, at 16, met the gas with a naked light in No. 8 west on its return to the fan and was blown down the room to the point where his remains were found. It is possible that one of the men found at 18 on the main entry may have lighted the gas in the return west air-way at or near its intersection with No. 8 cross-entry, in which event the force exerted at that point was sufficient to have blown him to where these bodies were found. From all the evidence, however, I am inclined to the opinion that the gas was lighted by the boy found at 16, as he was in a straight and direct line from the evident point of ignition, indicated by circles of force, like the ripples from a stone thrown into a pond of still water; and at every other point in the mine the forces can be traced to this origin as the center from which the waves emanated.

I was satisfied, from all I could see and hear, that the general plan and conduct of this mine were fully up to the standard of the New River district, and above the average in many respects. The presence of gas in dangerous quantities, however, was not fully realized, consequently some of the expense and precautions for a highly gaseous mine were omitted. Nor could the precautions necessary for such conditions have been instituted, in my opinion, without a loss at the prevailing market prices, as the additional costs would necessarily have exceeded the profits.

Both the operators and operatives of this district are unaccustomed to gaseous mines, and both must be educated to the requirements. The operator may comply strictly with every requirement, regardless of cost; yet the ignorance or carelessness of a single operative may bring about disaster without warning, and none may live to tell the tale. Many such cases are on record, and nothing but time, strict attention and experience will provide an adequate remedy.

ANNUAL MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

The eighth general meeting of the Society of Naval Architects and Marine Engineers was held at the house of the American Society of Mechanical Engineers in New York city on Nov. 15 and 16, with about 125 members in attendance. The programme consisted in the reading and discussion of a list of 13 papers and, with some exceptions where unnecessary time was consumed in reading the papers in full, the work moved along briskly and smoothly.

The first business of the meeting was the election of officers for the ensuing year and it resulted in the re-election of the old officers with the addition of Mr. Walter A. Post to the Council. The President, Mr. Clement A. Griscom, then read his annual address. The following is an abstract of some of the more interesting of Mr. Griscom's remarks:

PRESIDENT'S ADDRESS.

During the fiscal year of the Government, which ended in June, 80 steel steam vessels of 167,948 gross tons were built in the United States. These figures are modest compared with Great Britain's output of 567 steel steam vessels of 1,341,425 gross tons during the year; but they are full of encouragement when put beside the fact, that during the previous nine years the United States built only 574,802 gross tons of these types. Nearly all our shipyards have been busy, every large plant has increased its capacity, and several new shipyards have been established and equipped for the construction of the largest merchant and war vessels. The new ship and engine-building yard of noble proportions on the Delaware is prepared for work, and its novel applications of mechanical science to shipbuilding have already aroused the interest of the students of marine architecture here and abroad. A new and extensive plant on the Pacific coast will soon begin operations, and on the Thames, in Connecticut, the keels of two of the largest steamships ever built will soon be laid. Plants in the South are increasing their facilities, and under favorable conditions steel shipbuilding promises to become one of our distinctively national industries.

The next 24 months will show an increase over the past 24 months as great as the records of the latter exceed those of previous periods. Since the end of June there have been launched, begun or contracted for, 78 steel steamships of 350,000 gross tons, including ten ocean steamships, each of 10,000 gross tons or over. Part of this work will extend over a period of two years, but in the twelvemonth from last June, 250,000 tons of steel steamships will have been launched in the United States. As your President, I deem it well at this time to point out some of the causes which, in my judgment, have brought about the recent remarkable growth in American shipbuilding, to which the figures just given testify.

Most familiar among those causes, has been the liberal and continuous expenditure of the Government on the Navy. Since 1884-5, 71 vessels of over 360,000 tons displacement, not including many torpedo boats and torpedo-boat destroyers, have been built or ordered for the Navy. The vessels under construction aggregate 113,326 tons displacement, namely, 6 battleships, 4 monitors, 6 protected cruisers, 16 torpedo-boat destroyers, 15 torpedo boats; total, 47. The total value now under construction for the United States Navy for hulls and machinery alone involves an expenditure of $33,700,000. The following vessels have been authorized, but not yet begun: 5 battleships, 6 armored cruisers, 3 protected cruisers; total, 14, aggregating 179,800 tons displacement, of which the hulls and machinery alone will cost approximately $50,400,000, a greater amount than is involved in the entire construction of the merchant steamships of 24 months to which I have referred.

The annexation of Hawaii and causes arising from our war with Spain have stimulated shipbuilding beyond the expectations of the sanguine a few years ago. Among such causes are the extension of the coasting law to Porto Rico, the development of closer relations with Cuba, the absorption of a large tonnage by the Government for transport purposes and especially the certainty that the United States is now impelled by the force of events to assume first rank as a maritime commercial power on the Pacific.

Under natural and legislative conditions which insure them against external competition and have obtained for them deep channels, our shipbuilders on the Great Lakes have brought the art to a wonderful perfection. Of the increase of 750,000 tons in American shipping during the decade, 500,000 tons—450,000 of which are steel steam vessels—stand to the credit of the shipbuilders and ship owners of the Great Lakes.

The report of the Secretary-Treasurer, Francis T. Bowles, U. S. N., showed the membership of the Society on Nov. 14, 1900, to be 669. The total receipts of the Society during the year were $6,115.56, to which was added a balance of $3,586.75 remaining over from the previous year, making a total of $9,702.31. The total expenditures were $8,009.57, leaving a balance of cash on hand of $1,692.74.

The first paper read was entitled "A Capacity Test of a Unique Form of Air Pump," and was presented by Mr. F. Meriam Wheeler. There was an error in printing this paper by which incorrect cuts had been used, and we shall therefore postpone its consideration.

INTERCHANGEABILITY OF UNITS FOR MARINE WORK.

This paper, by Mr. W. D. Forbes, called attention to the recognized desirability of interchangeable machine parts and advocated the extension of the same principle so as to bring about interchangeability of units in ship's auxiliary machinery. The author believed that this could be done without making it necessary to use any particular make or style of machinery. To illustrate the idea it was proposed that all generating sets, for instance, of the same kilowatt output, should have the base plate holding-down bolts in exactly the same position and the steam outlets and inlets in exactly the same relative positions in vertical and horizontal planes. The author presented several diagrams illustrating the comparative ease with which the improvement proposed by him could be carried out in many instances, providing manufacturers and ship builders would only come to an agreement to accomplish it.

DISCUSSION.—Naval Constructor Francis T. Bowles, in opening the discussion, directed attention to the extreme importance of the improvement suggested in the paper. He believed that the principle could be extended outside of the engine-room auxiliaries to a vast number of the appliances and fittings used on shipboard. He had been at work for some time standardizing fittings, such as eyebolts, blocks, pulleys, cleats, bits, ventilator rings, etc. Mr. John C. Kafer wished to endorse all that had been said by Mr. Bowles as to the importance of standardization of units on shipboard and thought that could the manufacturers of ship fittings agree on standards there would be no trouble in getting the shipbuilder to adopt them. Mr. Wm. J. Baxter called attention to the extent to which the Pennsylvania R. R. had standardized the machinery equipment of its vessels. To show the advantage which might result from this practice he instanced the case of one of the company's ferry-boats in which one of the engines was smashed. As it was important to keep the boat in sevrice, an engine from one of the company's tug boats was removed and placed in the ferry-boat within a very short time, this change being made possible by the fact that the machinery on the two boats was interchangeable. Mr. F. M. Wheeler thought that it would be a matter of great difficulty to arrive at any agreement on such standards, and also felt that if carried out it placed obstructions in the way of future improvements. After some further discussion in favor of the idea suggested by the paper, Mr. W. M. McFarland made a motion that a committee should be appointed by the President of the Society to consider the question of standardizing the units on shipboard and to devise or suggest means for accomplishing it in a practical way.

PERFORMANCE OF THE RUSSIAN CRUISER "VARIAG."

This was a supplementary paper contributed by Mr. Charles H. Cramp, and it described briefly the performance of the remarkable vessel named during its 12-hour trial trip during the past summer. Owing to the general interest which the performance of this vessel has aroused, Mr. Cramp's paper, which gave more complete details than had hitherto been available, was received with close attention. The following extracts are taken from the paper:

The facts to which I care to call your attention are: (1) That no full-speed trial has hitherto been required of 12 hours' duration under natural draft. (2) Nothing approximating the speed developed by the "Variag" has even before been attained in any vessel or required by any contract to be effected under natural draft alone.

To the first of these statements I might add that in the contract for the construction of the "Variag" it was stipulated that a speed of 23 knots per hour for twelve hours might be attained in two runs of six hours each, with a short interval between them sufficient to rest the fire and engine-room forces a little, but prohibiting any overhaul or changing of any kind in the boilers and machinery during the interim. As it turned out, we did not consider it worth while to avail ourselves of the intermission, but ran the whole trial continuously over the twelve hours.

It may also be within the bounds of propriety to suggest that the extraordinary performance of the "Variag" under the remarkable conditions that were imposed, cannot be taken by our own Government as a standard, if they adhere to the scale of statutory limitations of cost hitherto incorporated in the Acts of Congress authorizing naval vessels. The Russians, while making drastic requirements, were also willing to pay the price necessary to obtain what they wanted. I am free to say that the statutory limitations hitherto placed upon the cost of vessels of approximately similar class to the "Variag" would prohibit the building of such a ship within such limitations.

Table Comparing Dimensions, Equipment and Speed of the Russian Cruiser "Variag" with Other American and English Built Cruisers of the Same Class.

	United States built			English built.			
	Russian "Variag."	U. S. S. "Minneapolis."	U. S. S. "Olympia."	"Terrible."	"Diadem."	"Blanco Encalada."	"25 De Mayo."
Length, load line.	419′ 6″	412′	340′	520′	435′	390′	345′
Beam, extreme ..	52′	58′ 2¼″	53′	71′ 6″	69′	45′ 9″	43′
Trial drafts	19′ 6″	22′ 6½″	21′ 6″	27′	25′ 3″	18′ 5″	16′
Displacement ..	6,465 tons.	7,375 tons.	5,586 tons.	14,200 tons.	11,000 tons.	4,568 tons.	3,200 tons.
Indicated HP. ...	15,925	20,862	17,313	25,000	16,961	14,500	13,800
Speed	23.25 knots.	23.07 knots.	21.69 knots.	22(?) knots.	20.72 knots.	22.80 knots.	22.43 knots.
Duration of trial..	12 hours.	4 hours.	4 hours.	.....	8 hours.	Meas. mile.	Meas. mile.
Coal capacity ...	1,250 tons.	1,891 tons.	1,170 tons.	3,000 tons.	.....	866 tons.	.....
Coal on trial . ..	770 tons.	629 tons.	153 tons.	1,000 tons.	1,000 tons.	350 tons.	300 tons.
Battery	12 6″ R.F. 12 75mm.* 6 47mm. 2 37mm. 2 field.	1 8″ B.L.R. 2 6″ & 8 4″* 12 6-pdrs.* 4 1-pdrs. 4 Gatlings.	4 8″ B.L.R. 10 5″ R.F. 14 6-pdrs.* 6 1-pdrs.* 4 Gatlings.	2 9.2″ 12 6″ R.F. 18 12-pdrs. 12 3-pdrs.	16 6″ R.F. 14 12-pdrs.* 12 3-pdrs.*	2 8″ R.F. 10 6″ R.F. 12 3-pdrs. 10 1-pdrs.	2 8″ R.F. 8 4.7″ R.F. 12 3-pdrs. 12 1-pdrs.
Complement	580 men.	477 men.	446 men.	840 men.	600 men.	429 men.	185 men.
Type of boilers..	Niclausse.	Scotch.	Scotch.	Belleville.	Belleville.	Scotch.	Scotch.
Type of engine...	4-cyl. triple-expansion.	Triple exp.	Triple exp.	Triple exp.	Triple exp.	Triple exp.	Triple exp.
No. of screws....	2	3	2	2	2	2	2
Weights:							
Hull, boilrs, &c.	4,706 tons.	6,096 tons.	4,696 tons.	10,702 tons.	8,412 tons.	3,568 tons.	2.516 tons.
Ordnance	547 "	230 "	327 "	.....	652 "	400 "	210 "
Equip. and outfit	442 "	420 "	400 "	.....	936 "	250 "	140 "
Coal	770 "	629 "	153 "	1,000 tons.	1,000 "	350 "	300 "
Total†	1,759 tons.	1,279 tons.	880 tons.	3,498 tons.	2,588 tons.	1,000 tons.	650 tons.
Per ct. of weight‡	37.40	20.90	18.70	32.60	23.50	28.20	25.90
Coal to tri'l dis.	12.0	8.40	2.70	7.00	9.10	7.70	9.60
Ord. to trial dis.	8.40	3.10	5.70	....	5.90	8.80	6.60
Speed	23.25 knots.[1]	23.07 knots.[2]	21.69 knots.[3]	22(?) knots.[3]	20.72 knots.[3]	22.80 knots.[4]	22.43 knots.[4]

*Rapid-fire guns. †Weight of ordnance, coal, equipment and outfit. ‡Of ordnance, coal, equipment and outfit to weight of hull, boilers and engines. In speed trials: [1]For 12 hours' natural draft; [2]for 4 hours' forced draft; [3]for 8 hours' natural draft; [4]Per measured mile, forced draft.

it might be proper, even at the risk of expanding my comment more than I had originally intended, to say that if we divide the weights carried on the official trial displacement into two groups, one of which will include the fixed weights or those necessarily devoted to the hull and machinery and the other of weights of ordinance, coal, equipment and outfit, which may be summed up under the term of load carried at trial displacement, we find that the load carried in the case of the "Variag" exceeds that of any other vessel given in the table. To show this more clearly, the weights of coal, equipment, etc., are given in a percentage of the fixed weights. In the "Variag" this percentage is 37.4, the next highest being the "Terrible" with 32.6 and ranging down through various ships to 18.7 in the "Olympia."

Analyzing these results we find two important facts, namely, that the load of the variable weights of the "Variag" are exceedingly high, and that the weight of hull and machinery is comparatively low. By reference to the table it will be seen at once that the displacement in this vessel devoted to coal and ordnance is extraordinarily high, being unequalled by any vessel of her class hitherto constructed. The fact of carrying 12% of the displacement in coal at trial draft is unparalleled in modern cruisers of high speed in all classes. The great weight of ordnance carried is equalled only by the "Blanco Encalada" of the Chilian Navy, built by Armstrong. It is here more than in any other particular that the "Variag" becomes a triumph of architectural and engineering skill. Recurring to the table we find that the percentage of displacement devoted to the hull and machinery of vessels fitted with water tube boilers is as follows:

	Displacement.	Speed.	Duration of Trial.
"Variag"	72.8%	23¼	12 hours
"Terrible"	75.4%	22	8 "
"Diadem"	76.6%	20.72	8 "

The value of this reduction of such weights in the "Variag" to the minimum, without impairing the structural integrity of the hull, and the delicate nature of the task which it imposed, may be better understood when I say that the requirements of the Russian Government were that the maximum stresses upon the hull structure must not exceed 5 tons per sq. in. of material, and that this requirement was carried out with a considerable margin, to the satisfaction of the Russian Inspecting Officers, notwithstanding the low percentage of such weights to displacement. As further evidence of the perfect structural integrity of the hull, I may say that the watertight compartments have been tested with a maximum head of water equal to that which would be due to immersion of the vessel to the upper deck line. This is a test of unheard-of severity, not having been applied to any other ship within my knowledge, but it has been carried out thoroughly and to the entire satisfaction of the Inspectors. I speak of this as only one of the conditions to be dealt with in calculating and preparing the scantling sizes of the hull. Another fact of great interest in this connection is that the vertical vibrations of the hull at varying speeds were, at the maximum, very small, and under most conditions practically imperceptible.

THE UNITED STATES EXPERIMENTAL MODEL BASIN.

This paper, by Naval Constructor D. W. Tayler, U. S. N., described in detail the basin constructed by the U. S. Government for testing models of vessels. A description of this important structure prepared by Mr. Tayler was published in Engineering News of July 6, 1899, and it will not be described further here. The discussion was brief and consisted chiefly in expressions of appreciation of the paper. In answer to questions, the fact was mentioned that the basin would be available for conducting tests by private shipbuilders at all times when Government work was not being carried on.

THE COMPOSITION AND CLASSIFICATION OF PAINTS AND VARNISHES.

This paper, by Prof. A. H. Sabin, was a general description of the composition of paints and varnishes, with particular mention of ship's bottom paints. A complete list was given of the patents on ship's bottom paints. The following general statement was made as to their character and action:

In general, the subject of painting the bottoms of iron ships may be divided into the preservation of the metal from corrosion and the prevention of fouling. The former is secured by applying any good anti-corrosive paint, and the problem, so far, is like the preservation of metallic structures in general. Some of the paint manufacturers attempt to do this by a special paint; others aim to make their anti-fouling compound keep the water from the metal plates and serve both uses. The anti-fouling paints work by poisoning the organisms which attach themselves to the ship, and are chiefly of three kinds. One of these has for its active agent the oxides of copper; these were, in the first instance, ground and mixed with Stockholm tar. The copper was supposed to dissolve slowly and to kill the adhering organisms. Its use was suggested by the successful use of copper sheathing on wooden ships, but the generally accepted theory of the action of copper sheathing is that it acts, not by poisoning, but by a process of exfoliation or scaling off; that animals attach themselves to it, but that an outer layer of the copper peels off and leaves a fresh surface. The writer has had no considerable experience with copper sheathing, but has been told by experienced shipbuilders that copper plates often seem to have this foliated structure only near the surface, and after two or three years' use the more solid and unstratified body of the plate is reached, after which no considerable protective action is noticed. If this is the case it is difficult to see how a copper paint will give much protection; but this is a matter in which facts are of more use than theory. Another sort of copper paint is a copper soap, made by precipitating a solution of common soap with a solution of some salt of copper, thus making an oleate or some similar salt of copper. This is a soapy or greasy substance, insoluble in water, and is applied hot, making a thick coating. This is not a good foundation for animals or plants to attach themselves to, and it is continually wearing away. Such a material is very different from any ordinary paint, and is more like a coating of cement than a paint, but it is commonly classed here. Some of the paints of this class give good results, but, of course, they must be frequently applied. They do not, however, need any time to dry, hence the ship may be put in the water immediately, which is one of the essentials in much of the work on ships' bottoms. The third, and at present, the most numerous class of paints, are the varnish paints, already partly described, made from a spirit varnish. The pigment in these may be almost anything; commonly it is oxide of iron, sometimes with some white lead or white zinc; sometimes the coloring matter is Paris green, or some green pigment suggesting copper. The poisonous matter may be some arsenical compound, but in some of the most successful ones it is a mercury compound. The arsenical compounds are very cheap, and are undoubtedly poisonous, but the mercury compounds are more intensely poisonous, that is, they poison with a less amount, but they are very expensive, costing for the most part about a dollar per pound of contained mercury. It may be doubted whether there is much choice among the mercury compounds, as the sea water will convert any of them into corrosive sublimate. The essential thing seems to be to get a varnish which will last as long as possible, regard being had to the absolute necessity of having one which will dry almost immediately, then to put in enough mercury or other poison to last as long as the varnish does, in quantity sufficient to kill everything with which it comes in contact. The points to be investigated, therefore, are to find out what resin or mixture of resins will give sufficient hardness to resist the abrasive action produced by the passage of the ship through the water, together with enough toughness to prevent it from flaking off; it must also be as nonporous as possible, so that the water may not be able to dissolve out the poisonous matter too rapidly. The nature of the solvent which is used to dissolve the resin has also something to do in this matter. It may be found advisable to dissolve the poisonous matter in the solvent, or it may be disadvantageous to do this. The common practice has been to use mineral poisons; but organic ones may, in the end, prove most suitable. One of the patents quoted specifies the use of hydrazin or some similar coagulant poison; in view of the success which has attended the use of mercury, which is a mineral coagulant poison, this may be worth thorough investigation. In ordinary varnish making it is necessary to use mixtures of varnishes made from different resins to get the desired qualities; it would then be only reasonable to expect to have to do the same thing in this case. Sea water, which holds in solution every common elementary substance in some compound, is a great solvent and a chemical agent of unknown but certainly great powers; and this whole matter, which, so far as is known to the writer, has never been the subject of any very systematic investigation, will require many years of connected and intelligent work before it can be claimed to be on any such basis as our knowledge of paints for ordinary use. What seems to have been done so far is that manufacturers have invented or bought formulae of more or less value and put paints made by these on the market; if they were of any merit they have survived; but there seems to be no connected body of knowledge concerning the subject. Oil paints have been used for ships' bottoms, but have not been satisfactory on account of the perishable nature of oil films in sea water; some success has been had with paints made with oil and resin varnishes, but if these dry quickly they are perishable, and where durable varnishes have been used they have been too slow for work which has to be hurried. The writer has lately—about a year and a half ago—started a set of systematic experiments on this subject, but it will very likely be some years before any results worth publishing will be reached.

DISCUSSION.—The discussion of this paper was brief and referred principally to ships' bottom paints. Mr. Francis T. Bowles, U. S. N., summed up the general feeling quite well in the following statement: "We know that all of the so-called ships' bottom paints are expensive, and that none of them are of much benefit, and that is about all we do know."

The next paper read was one by Naval Constructor J. J. Woodward, U. S. N., on the "Tests of the Electric Plants of the Battleships 'Kearsarge' and 'Kentucky.'" This paper was very long and entered in great detail into the numerous tests which were made of the generator plant, turret turning machinery, ammunition hoists and the various electrically operated auxiliaries. This paper was followed by one by Mr. Spencer Miller, M. Soc. C. E., describing the "Coaling of the U. S. S. Massachusetts at Sea," using the Miller cableway. This cableway and the tests made with it were fully described in Engineering News of April 5, 1900.

NOTES ON RECENT IMPROVEMENTS IN FOREIGN SHIPBUILDING PLANTS.

This paper, by Naval Constructor H. G. Gillmor, U. S. N., is reprinted elsewhere in this issue. It was followed by a paper by Mr. Geo. W. Dickie, entitled "Can the American Shipbuilder, Under Present Conditions, Compete With the British and German Shipbuilders in the Production of the Largest Class of Ocean Passenger and Freight Steamships?" An abstract of this paper is given elsewhere in this issue. The two papers by Mr. Gillmor and Mr. Dickie were discussed together, the principal part of the discussion relating to Mr. Dickie's paper.

DISCUSSION.—Mr. W. I. Babcock thought that as far as skill in designing and cost of material were concerned, the United States would be at no disadvantage as compared with foreign countries. The cost of labor was a more serious matter. Mr. Dickie, in his paper, had stated that as far as the cost of labor on the steelwork of the ship was concerned, the United States was now on an equal basis with Europe. On the Great Lakes the cost of labor for steelwork for freight carriers was about 30% of the total cost, and the cost of labor for all other work ran from 7% to 12% of the total cost. If, as Mr. Dickie said, and as he believed, the United States and Europe stood on the same basis as regarded the cost of labor for the great bulk of the labor cost of the ship, it was even now only a matter of equalizing the labor costs for the remaining small proportion of the work and he thought that this could be done. The wages paid in America were higher, but the men turned out more work than did the workmen in foreign ship yards. The reason for this was that the men in American yards worked more steadily; there were fewer intermissions in the working day, each of which meant a loss of efficiency previous to stopping work and for a short time after it was resumed again, and, finally, that the men were less under the control of the labor unions. It was a common thing in English ship yards for a man to lose 30% of his time. Mr. Lewis Nixon considered that it was idle to talk of American builders being able to compete with English and German builders until they had, like the foreign builders, enough work to keep their yards full of large vessels under construction. In an English ship yard it was the common thing to have every slip filled with a large vessel, all of them being similar and often several of them identical in size and type and in the character of the work required. In American yards the builder would have a battleship in one slip, a tug in another and a ferry-boat in another; and it was impossible to classify and systematize work as could be done under the more favorable conditions abroad.

RECENT DESIGNS OF BATTLESHIPS AND CRUISERS FOR THE U. S. NAVY.

This paper, by Rear Admiral Philip Hichborn, Chief Constructor, U. S. N., described and gave general plans of the new battleships and armored cruisers for the U. S. Navy, and it will be given in abstract, with the illustrations, in a future issue. There was no discussion.

COMPARISON OF THE CONTRACT PRICES OF OUR NAVAL VESSELS.

This paper, by Mr. Harrison S. Taft, was intended to show by tables and diagrams the relative cost of the different vessels in each of the seven classes composing our navy; the relative prices between the different firms in different parts of the country; the relative prices of the different classes, one to another, and the direction in which prices have been tending.

In the discussion the paper was criticised for having confounded price with cost and for having wrongly classified certain vessels, thus vitiating the comparisons made.

The next paper, entitled "The Launch of a Cruiser and a Battleship," by Mr. James Dickie, was read by title only. It is reprinted elsewhere in this issue.

THE SAFETY OF TORPEDO BOATS AT SEA.

The author of this paper stated that some years ago he had made calculations in regard to the trim and stability of the torpedo boat "Ericsson," and had lately repeated these calculations for the "Bagley," "Barney" and "Biddle," now in the course of construction. The results of these calculations were given in the tables and diagrams accompanying this paper. In conclusion, the author said:

It will be seen from the diagrams that the chances of total loss of a torpedo boat are not so desperate as one might be led to expect, and the writer has found from stability and other calculations that the service on a well-designed and well-handled torpedo boat is not by any means as dangerous as it is supposed to be.

By the use of gas escapes from the ash pits, together with approved methods of closing fire and ash pit doors, as well as automatic boiler stop valves (to prevent a rush of live steam in case of accident to a steam pipe), the danger to the men in the engine and boiler rooms has been considerably decreased.

Another source of safety to the torpedo boat, as well as to the personnel, which should be counted on (when torpedo boats attack in formations of two or more), is that a disabled boat might be quickly towed out of action, either bow or stern first, and, while the complete system of ejectors and pumps is clearing a bilged compartment, the leak or leaks may be temporarily stopped to enable the boat to make her way to a place of safety; or, with an officer in command full of resources, she might continue her allotted programme of attack.

In regard to the seaworthiness of torpedo boats, they usually have a large range of statical stability. The angle of vanishing stability varies from about 70° in some torpedo boats up to and beyond 90° in the case of the "Ericsson." It may be remarked here in passing, that the writer considers the shallow draft of some of our torpedo boats as carried to an extreme. They should, it is thought, be slightly deeper than usually designed, to increase their stability and seaworthiness.

The safety of the whole construction of the vessel depending on the integrity of the deck and side plating in a sea way, as far as the above water portion of the torpedo boat is concerned, there is but little hope in a rough sea for a torpedo boat when the decks or sheer strakes, or both, are seriously cut up or injured amidships from shell fire, thus destroying the upper flange of the girder represented by the construction of the torpedo boat. This danger is unavoidable.

Another source of danger is due to driving these light constructions at full speed into a head sea. If good judgment is not exercised, the result will be that the bows will be stove in, bent, and twisted. This actually occurred to one of the torpedo boats built for the Spanish Government, and hurried to Spain just before the outbreak of the Spanish-American war.

A CONVERTIBLE DAY, PARLOR AND SLEEPING CAR.

In an editorial on "Passenger Traffic and Passenger Profits on American Railways," in our issue of Aug. 16, we expressed the opinion that there is an opportunity for railways to increase their profits by providing improved accommodations for certain classes of passengers, and more particularly for those traveling short distances and those who find the Pullman service too expensive. It is pretty certain that many passengers who would not incur the expense of a seat in a Pullman parlor or sleeping car, would be willing to pay a small extra price to secure more room and privacy and

cleaner and more comfortable accommodations than are afforded by the ordinary day coach.

The difficulty which has always been met in putting this plan in operation is that a whole car must be provided for the special class of passengers, and the demand for its accommodation varies greatly. Many days it will run completely filled, but on many other days it will run nearly empty. The only way in which this difficulty can be met is by some form of convertible car, which can be altered according to requirements by the train crew, so that any part of it can be made up as a parlor or sleeping car and the remainder as an ordinary day coach.

Since the publication of the article above referred to, our attention has been called to a new design of convertible car which has been made with the object above named in view. It is termed an "Individual Compartment" car, and can be altered to provide either ordinary or special accommodation by day, and sleeping accommodations at night, thus combining the features of day, parlor, compartment and sleeping cars.

The design embraces four special features: (1) Transverse roller curtains and folding partitions between the seats and hanging curtains along the aisle; these shut off sections or compartments, as desired, by day or night; (2) improved foot rests and lifting seat-backs which permit the formation of full length sleeping berths; (3) special seat arm attachments which enable the seats to be adapted as lounges or reclining chairs by day; (4) sleeping berths placed diagonally along each side of the car giving a large number of berths of medium width, and each the full height of the car.

It will be seen from Fig. 1 that the car has a series of transverse ribs or carlines above the windows and directly above the backs of the seats. These house the spring roller curtains which form the partitions when required during the day. The ribs also carry the longitudinal brass rods for the portieres. A single day compartment, with curtains drawn down to enclose one seat, and accommodating one passenger, is 42 × 42 ins. in area. A double compartment for two seats and two passengers is 42 × 72 ins. The 24-in. space between the seats is available as standing room in each compartment. Attached to the side of the seat, and normally forming the arm, are two upholstered leaves, which may be adjusted in various positions to form a rest for the back and head like an easy chair (for sitting upright), or extended to form a pillow for reclining or sleeping by day. This gives exceptional ease, especially in providing for much greater change in position than can be secured with the revolving chairs of an ordinary parlor car or the fixed seats of a sleeping car. Adjustable foot rests also add to the facilities for comfortable lounging during the day. These foot rests, which serve as well to build up the sleeping berths, are hinged in pairs on either side of the seat frames, and are normally under the seat.

Folding partitions or light screens are used to form the compartments at night, and extend from the seat cushions to the ceiling formed by the lockers for bedding. When not in use they are folded back into recesses in the side of the car between the windows. For a single night apartment, the partitions are placed diagonally as shown, so as to give ample length for a passenger lying diagonally across the berth. To make up a berth, the two pairs of foot rests facing each other on adjoining seats are raised to fill the space between these seats. The intervening roller curtain is raised, carrying with it the seat-back to the top of the car. Two folding partitions are then swung into place, forming a single compartment 6 ft. 6 ins. long (diagonally), and 42 × 84 ins. in the double compartment. The two rests nearest the aisle need not be raised until the passenger is ready for bed, thus leaving a floor space 21 × 24 ins. for disrobing while standing erect—a much more comfortable arrangement than that furnished by the ordinary sleeping car. No upper berths are provided, it being considered that when these are used it is impossible to give the desired comfort or accommodation. The compartments, therefore, extend the full height of the car, while the number of lower berths is greater than in the largest Pullman cars. Thus a Pullman car with 16 sections would accommodate only 16 passengers in lower berths (except where two persons share a berth). The "Individual Compartment" car, however, would provide 30 passengers with lower berths for their own exclusive use. The bedding, portieres, etc., are stored in the lockers between the transverse ribs or housings, and conveniently situated under these are lockers for the reception of passenger's light baggage. There is no such provision in ordinary sleeping cars, where the disposition of valises and parcels is always a source of more or less inconvenience. Each compartment has an exhaust ventilator, and any system of lighting can be introduced, with independent lights to the compartments, if desired.

The car may be operated in both day and night service, like a Pullman sleeping car, or it may be run in only one service, according to the traffic requirements. For day service, it may be operated as a regular day car or as a parlor car, or with part made up in one manner and part in the other. In the first case, the seat attachments, foot rests, etc., are locked, and there are two passengers to each seat. In the second case, the attachments are released and adjustable, and each passenger has a seat to himself. The curtains of any compartment may be kept drawn during the day, forming private compartments, a feature which would be specially appreciated by invalids or by ladies traveling alone. The plan, Fig. 2, represents a car 72 ft. long, with 30 special seats 21 ins. apart, and also two staterooms (a ladies' room and a smoking room), and two toilet rooms. The 30 seats can be used to form single or double compartments at will, ranging from 2 single and 14 double compartments to 30 single compartments. When arranged as an ordinary day car, there is accommodation for 74 passengers (including 14 in the staterooms). As a parlor car, it will accommodate 44 passengers (14 in the staterooms). As a sleeping car it will accommodate 34 passengers (4 in the staterooms).

The flexibility of the car in respect to accommodation, makes it specially adapted for lines where the demand for parlor or sleeping accommodation is limited. This flexibility is also the basis of claims as to economy in both first cost and in operation, as on routes with light traffic the one car may provide different classes of accommodation, separated by transverse curtains. Parlor and sleeping cars are very often run almost empty for a considerable proportion of their mileage, and while sleeping cars are used also in day service, parlor cars are unavailable for night service. With a convertible car, the mileage and the percentage of live load to dead load might be materially increased. There appears to be a field for a car of this type, and, as pointed out in the editorial above referred to, it should be possible for the railways to make such a service profitable to themselves and popular with the public.

The designs for this "Individual Compartment" car have been originated and worked out in detail by Mr. J. B. Strauss, C. E., 1742 Monadnock Block, Chicago, to whom we are indebted for the plans herewith reproduced.

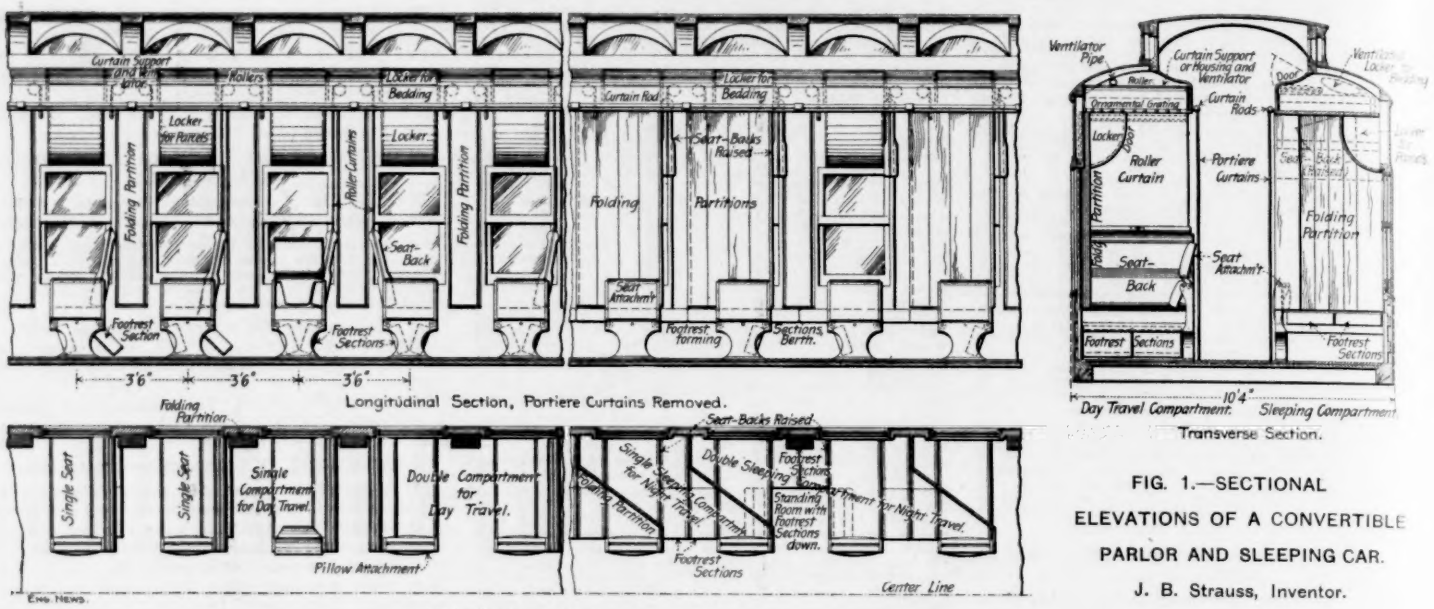


FIG. 1.—SECTIONAL ELEVATIONS OF A CONVERTIBLE PARLOR AND SLEEPING CAR.

J. B. Strauss, Inventor.

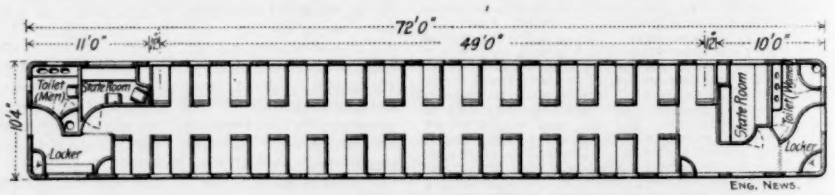


FIG. 2.—PLAN OF CONVERTIBLE PARLOR AND SLEEPING CAR.

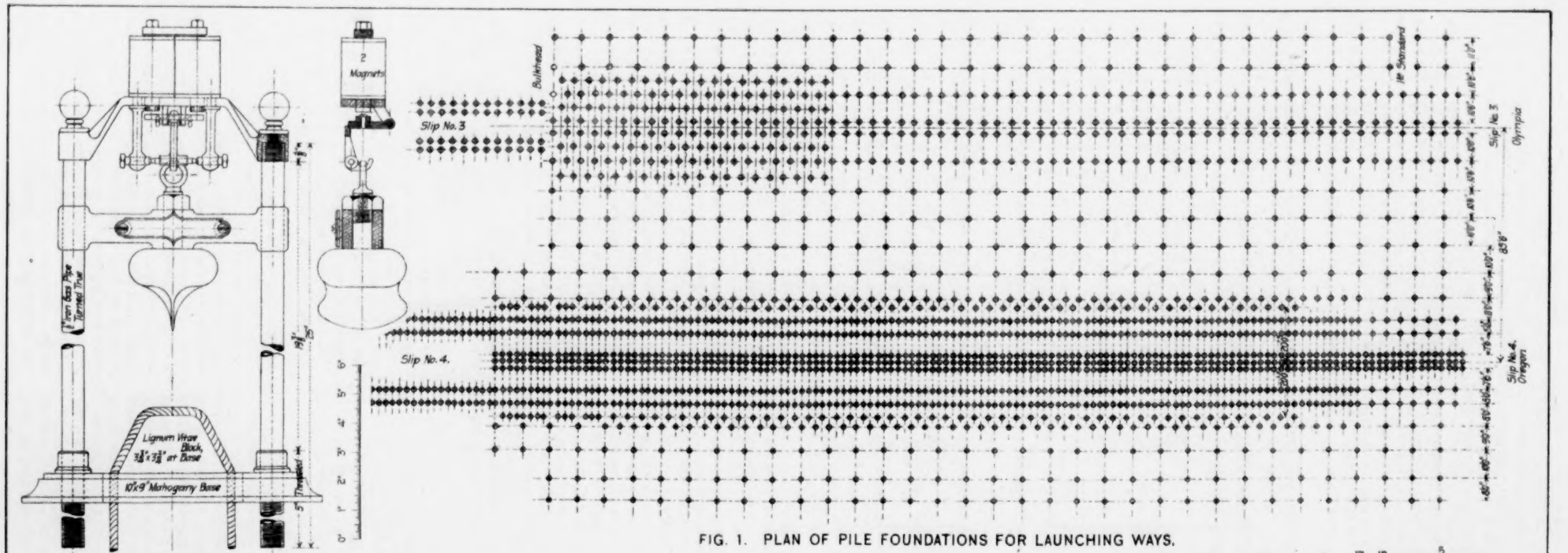
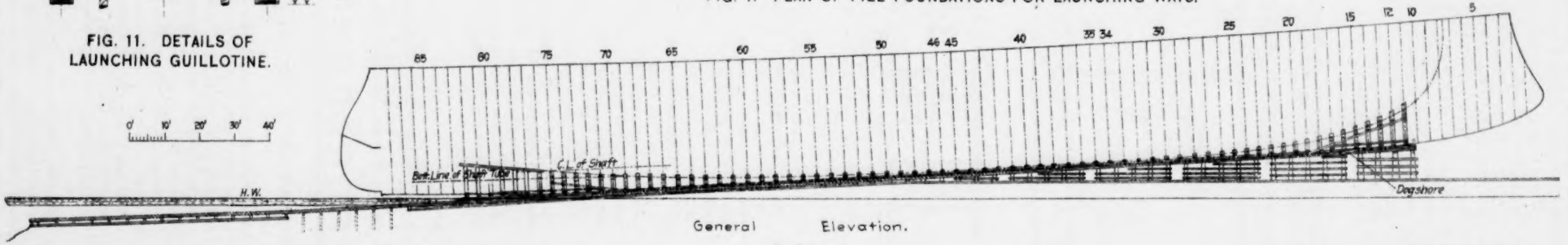


FIG. 1. PLAN OF PILE FOUNDATIONS FOR LAUNCHING WAYS.

FIG. 11. DETAILS OF LAUNCHING GUILLOTINE.



General Elevation.

Fig. 2.

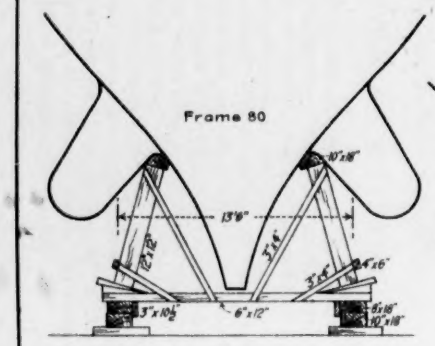


Fig. 7.

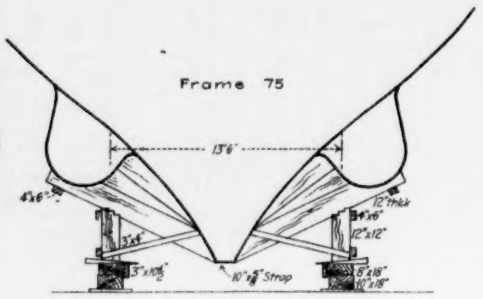


Fig. 5.

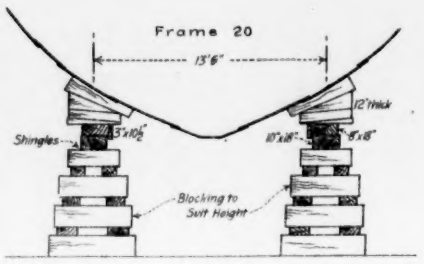


Fig. 8.

Fig. 3.

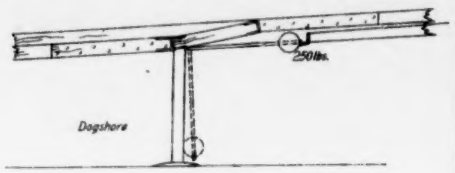
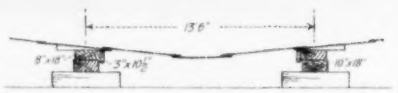


Fig. 9.



Frame 46

Fig. 4.

FIGS. 2 to 9.
DETAILS OF LAUNCHING WAYS
FOR CRUISER.

DETAILS OF LAUNCHING WAYS
FOR CRUISER

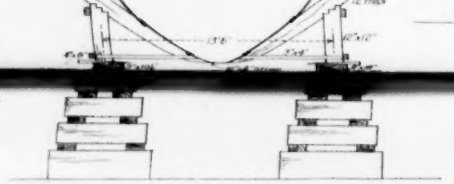
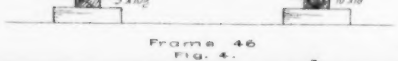
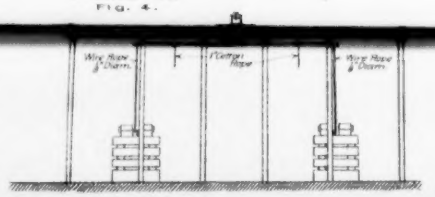


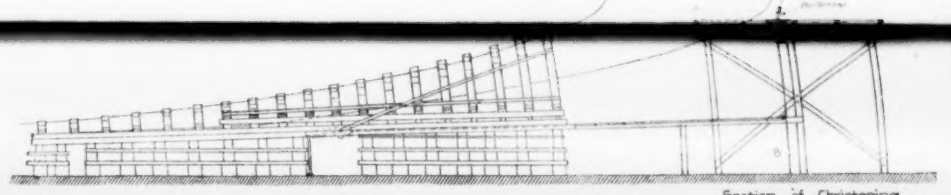
Fig. 6.



Frame 46
Fig. 4.

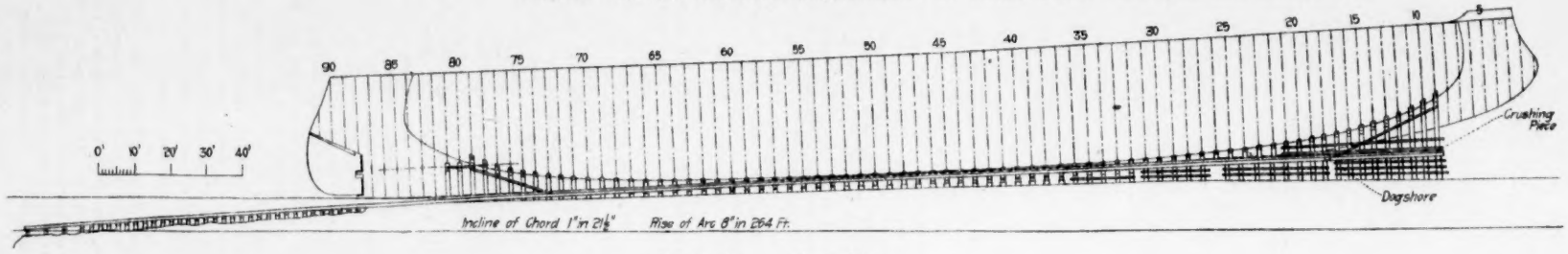


Section A-B.



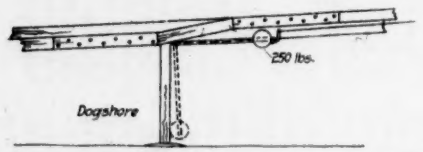
Section of Christening Platform at Guillotine.

FIG. 10. SKETCH SHOWING ARRANGEMENT OF CHRISTENING PLATFORM AND GUILLOTINE.

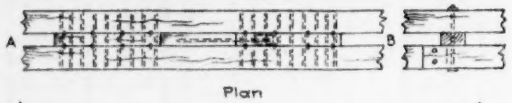


General Elevation.

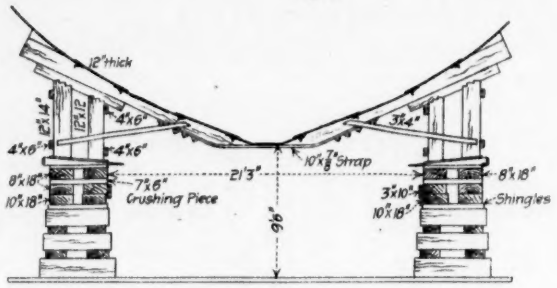
Fig. 12.



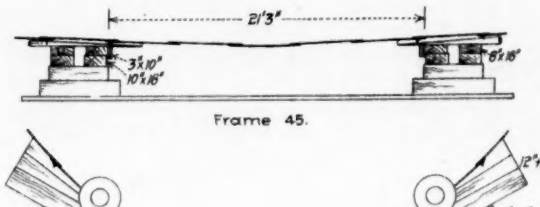
Section A-B.
Fig. 14.



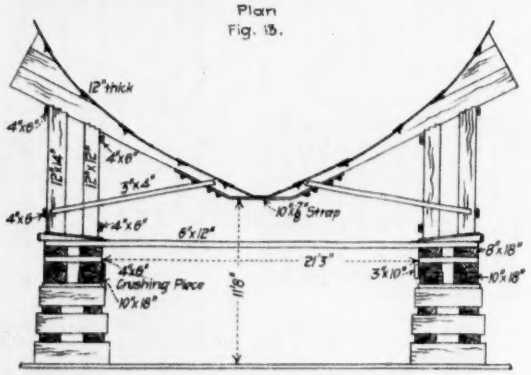
Plan
Fig. 13.



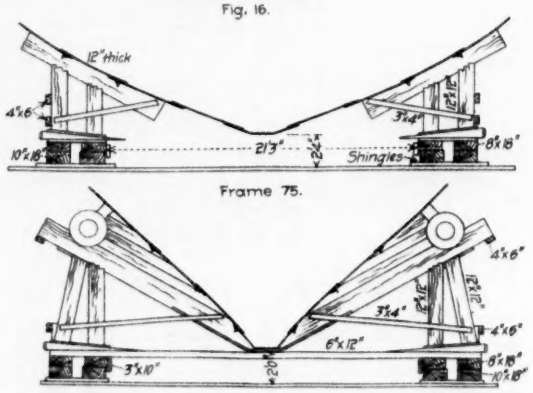
Section at Frame 12
Fig. 16.



Frame 45.

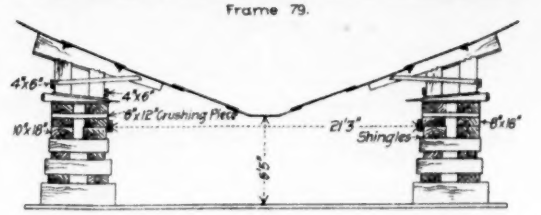


Section at Frame 9
Fig. 17.



Frame 75.

Frame 81.



Frame 79.

Frame 17.

FIGS. 12 to 17. DETAILS OF LAUNCHING WAYS FOR BATTLESHIP.

LAUNCHING WAYS FOR BATTLESHIP AND CRUISER.

Union Iron Works, San Francisco, Cal.

CHAS. HART, LITH., 86 VESEY ST., N. Y.